EXHIBIT S-24-1

Notes on Interviews with Harold Parrett in November 2010

Harold Parrett

Notes from the November 5, 2010 Meeting and Conversation
and November 8, 2010 Follow-Up Telephone Conversation
with corrections suggested by Mr. Parrett on November 16 and 18, 2010
regarding his history and involvement at the Burgard site

On November 5, 2010, Steve Schell met with Harold Parrett at the Burgard site, and on November 8, 2010 received additional information from him by telephone. Mr. Parrett lives at (b) (6), Portland, Oregon 97221 (b) (6) and his telephone number is (b) (6) Mr. Parrett was born in on (b) (6). He retired from Northwest Pipe in 1998. (b) (6), he went to work for Schnitzer breaking up liberty ships at Burgard. In 1959, he switched to working indoors at Beall Pipe and Tank Co. Beall was just finishing up a contract for pipe for the Bull Run system when Mr. Parrett came on board.

When Mr. Parrett started at Beall, Bays 1, 2, and 3 were separated from the other bays and filled nearly up to the overhead crane ways with wheat. The sign on the buildings was "Cargill." There were "keep out" signs all over the Bay 1-3 area. The Beall crew could not get near the wheat or drive around the south side of the bays. They got admittance to the property at the NE corner where there was a check in/guard shack.

Mr. Parrett first worked as a feeder for a manual hand blast operation in Bays 8 and 9 (all sandblasting uses steel grit). After this he worked as a scalp slitter for ERW (i.e., electric resistance welding) mills in Bays 5 & 6, and shortly after he started he came to operate the equipment. Later, Mr. Parrett moved to the Bell and End Forming Area where ends of the pipe were flared out so other pipe could be fitted within the flared-out ends.

During this time, asphalt was used to cover pipe. Before the 1960s bays fire, the welded pipe or galvanized culvert pipe would be horizontally submerged into a hot asphalt tank. After the 1960s fire, vertical tanks were used.

In another process, asphalt was applied to the exterior, top of the pipe and ran down over the pipe into a pan at the bottom of the mobile carrier that would catch the drippings. When the carrier ran out of hot asphalt, it would be moved to a large vat near the vertical pipe dipping area where the drippings would be placed back in the tank and the carrier reloaded. Sometimes during a break Mr. Parrett would talk with the employees applying the asphalt while he rode along on the carrier.

Prior to the early 1960s fire in Bays 10 and 11, the Beall tank, truck and trailer repair operation functioned. There was a cleanout area for the trucks and trailers just west of Bay 11 and north of what is now the lining and coating operation. There a steam jenny was used to scour the tanks so they could be worked on and welded. All sorts of cleanouts happened, from gas and oil tanker trucks and trailers to milk trucks. Thus, the cleanout could have accumulated many kinds of PAHs and other COCs.

In the early days, old steam boilers were cut in half and used as catchalls for waste paper and garbage. Two eyes were left in the half tank so it could be picked up with a

crane and emptied. Beall had a dump truck, and Mr. Parrett believes this truck was used to haul the refuse to the St. Johns landfill.

There are two kinds of welders used to make pipe, the spiral pipe welding machines, which use fusion welding, and the straight or tubular pipe operations, which use Electric Resistance Welders (ERW). Both are high electricity users. The submerged arc form of fusion welding process, which is used on the spiral pipe machines, uses generators not transformers.

In Bay 6 there was a straight seam pipe operation. Between Bay 5 and Bay 6, where the ERW machines were located, was the only area where transformers were on racks above the work floor. The transformers were complex equipment (something like big radio tubes that operated at several thousand cycles per second) and repairs of any significance were done by Therma Tool, a professional servicing company. The transformers in place prior to the 1960s fire would have had PCBs in them. The transformers had the caps welded on them, making them closed units, so any PCBs that may have been in them could not escape. During the Beall era their electrician was Bill Sheco; he may have had the ability to perform any repairs needed. Mr. Parrett knows of no time whatsoever where PCBs leaked out of those transformers containing PCB oil.

Mr. Parrett was experienced in applying coatings to pipe. Generally, the pipe needs to be cleaned by sandblasting using steel grit and then "flood coated" through a nozzle (known as a ware) to prevent rusting. Polyken is a tape used to wrap the pipe. It may have an undercoating of black tape. It comes in several colors – white for irrigation, blue for potable water, purple for sewers. Coal tar enamel is another coating which can be requested by customers. It is applied by heating the coal tar enamel and then drizzling onto the pipe through a funnel connected to a recirculating heating system for the coal tar enamel. Coal tar enamel can also be sprayed inside the pipe. Xylene is also used. It may have an undercoating of toluene or a primer of glue or mastic. If there is a spill of xylene or toluene, there is a talc that is kept readily available; it is placed on the spill immediately and absorbs the spill; after that it is swept up and disposed of off site. The ends of the pipe are frequently wiped down with rags and brushes. These used rags and brushes are collected and disposed of off site.

If the coal tar enamel process breaks down then the enamel hardens, the process has to be disassembled and the enamel has to be chipped out and reheated. The remnants are disposed of off site.

Two types of absorbents are used when spills occur: talc in the lining and coating area, and kitty litter (diatomite) where oil spills occur. Both are swept up and disposed of.

The line and coating area has a blower-fan system that captures the volatile chemicals into vents and passed them through a filter system. When the filter paper roll is used up it is treated as a hazardous substance and properly disposed of off site.

At some point, the discussion among the employees was that the Bealls owned a ranch in Eastern Oregon where they apparently could procure an absorbent, perhaps diatomaceous earth (the material kitty litter is made from). Mr. Parrett believes this may have

been used in the early operations. Again, after a spill it was used, swept up and disposed of off site.

Cleanup in the bays was done by sweepers. They deposited their sweepings in trash which was hauled away.

Johnny Beall and Franklin Beall both were commercial heads during those early times.

During the early years, Mr. Parrett reports that the rail line along the southeast side of the property had stored on it rail tank cars, which remained there for several years. He did not know what was in the tank cars or why they remained there so long.

Mr. Parrett has no recollection of why there should be hot spot in the area where Bays 7 and 8 had been, unless part of the activity, such as pipe coating, that went on in Bay 9 occurred in Bays 7 and 8 before the 1960 fires. Fittings (e.g. elbows and manholes) were sandblasted and painted in Bay 9 and may also have been painted in Bays 7-8.

Much of the waste was taken to the St. Johns Landfill.

On a Saturday morning in July at some time in the early 1960s, Mr. Parrett was playing pool at a local hang out and somebody came in saying the Beall facility had burned. He immediately went to the site, and all the bays had burned in about two hours. All the wheat that Cargill had stored in Bays 1-3 also burned. The bays apparently had been wood, the roofs with some of the sides being sheet metal. The roofs were underlain with tar paper. Only the twisted structural steel was left. A picture exists of the rubble in either the *Oregonian* or the *Journal* of that time (it apparently shows a big heap of debris).

After the 1960s fire and the cleanup, experts in structural steel repair came into the bays area and restored the structural steel by heating it and bending it back into place. The crane motors were rebuilt with new bearings. Rather than replace the wood, the current metal roofing and siding were used. In the reconstruction, a vertical asphalt coating operation was established in Bay 9.

In the reconstruction after the bays fire of the1960s, the horizontal asphalt application process was changed to a vertical dipping process in Bay 9. There were two sets of wells, one for heating the pipe and the other for applying asphalt. A group of pipes would be lowered into the heating chamber, then it would be raised into the tower and moved to the chamber filled with “pioneer mineral rubber asphalt” were it would be dipped then hoisted up into the tower and then dipped again until the right thickness per specification or custom order was achieved. At some point another product made by Shell was tried, but it came off and proceeded to clog people’s home water heaters in Parkrose. A law suit ensued against Shell, but at the appellate level Beall lost this case. Use of this vertical dipping operation had been discontinued before Northwest Pipe started operations on the site.

There were two coating operations, one in the smoke house and the other in Bay 9. In the Bay 9 operation, early on, asbestos imbedded in paper was applied as a coating. Also, Kraft paper with fiberglass or asphalt was applied over black 8 lbs. felt.

Another fire occurred after the recommencement of operations at Burgard in the spring following the early 1960s bays fire. This time the entire smoke house (coating and lining) burned. The fire was so hot that the metal of the building, including any zinc in the siding and roof, melted.

A third fire occurred before 1967, but after 1961. It was in the coating area of the lining and coating building. The rafters in the current building would still show some damage. Mr. Parrett thinks the Portland Fire Department might have records of these fires.

The operation had 8 or 9 forklifts, used for moving pipe and steel coils around. Near Bay 1 there was a group of barrels where the fluid was placed from forklifts being repaired. These barrels would fill up and be hauled off site. If the hydraulics on a fork lift or other equipment broke, there could be a loss of fluid of 10 to 15 gallons. Absorbent was used to sop up this loss.

Mr. Parrett discussed the Union Carbide operation. He said it was a nasty place. It may have caused cancer in North Portland and amongst employees who worked there. When there was a serious rain, the ditch coming out of the Union Carbide plant would overflow onto the Beall site and into the southerly bays. "It stunk like hell."

The flood of 1964 entered the lining and coating area and paper used to coat the pipes was moved out of that area and onto flatbed railroad cars so it wouldn't get wet (the same was done in the flood of 1996). The employees had about a 24-hour notice of the flood and had to work very diligently to save some of the motors, hydraulic units, air compressors and materials. Apparently, Beall was making aluminum boats at the facility at this time, and the employees were poling around the plant in the boats. Several of these boats disappeared in the flood. There are two Ackroyd photos of the site during this flood, C 8919-2 and C 4675-2.

In the 1960s, the culvert business was spun off, and Matt Conscentini purchased the culvert business from Beall and located property in Tualatin to start Oregon Culvert, using the skills acquired at Beall.

Beall had several pipe making machines. It had to pay royalties on the pipe footage coming from the ERW mills, which were owned by a group of share holders called Pipe Machinery, and they were headed up (Mr. Parrett thinks) by Earl Babbitt. As he understands it, Mr. Babbitt had bough two ERW bills from California to run at Beall. After the big fire, Beall decided to build their own mills and stop paying royalties to Pipe Machinery. Later, Beall built its own pipe making machines and got into a patent dispute with "Pipe Machinery," but Pipe Machinery lost to Beall. Thus, leaving the two ERW mills sitting at the end of Bay 6.

In about 1963-64, the Beall management came to Ralph Elle, Sr., who was the chief engineer and then about 62, and told him he was getting too old to run the Burgard operation. They replaced him. Mr. Elle went to several employees, including Gerald Seibert, David Bryant, and Harold Parrett, and asked them to join him if he could raise the money to establish a pipe making business. Mr. Elle acquired a site in Clackamas, and in 1967 bought from Beall: one 36" max. diameter spiral pipe making mill, a 1.4"-4" diameter peewee mill, a 3 ¾" x 8" diameter mill (#1), and later (in the late 1970s, possibly 1978) an 8" through 16"

diameter mill (#2). Mr. Elle commenced operations there under the Northwest Pipe and Casing name in the spring of 1967. At some time Mr. Parrett, who deemed himself qualified for a job in Bay 3, didn't get that job. Thus, in 1966 Mr. Parrett quit Beall and joined Mr. Elle to set up the machines and supervise the Clackamas operations. Thus, Harold Parrett left Burgard in 1967 and didn't return full time until about 1987, although starting in 1982 he was in and out of the Burgard site. Hence, Harold was not at Burgard during the time when L.B. Foster controlled Burgard.

In Bay 4 there was Mill # 7, an ERW. It was used for a short time in the late 1990s for making American Petroleum Institute (API) pipe. It is now in Texas.

Harold Parrett became a Field Rep for Northwest Pipe and Casing. He helped set up the plant in Atchison, Kansas in 1984-85. After that he spent 6 to 8 months initially at Vacaville and then helping set up the Adelanto plant in California. From May to September of 1987, he worked on a $7M job Northwest Pipe had for the City of Anchorage in Alaska. He worked on other installations and operations throughout the Willamette Valley and in Eugene.

Mr. Parrett was not at Burgard when the 1987 EPA transformer inspection occurred and has no recollection of the events, documentation or follow-up.

Although he wasn't present, Harold was aware of the labor troubles Beall/L.B. Foster had in the early 1980s. The issue was drug use, cameras and other inspections and monitoring; and the management insisted everybody take a drug test. The Boilermakers Union, which had organized the employees, ultimately decided that the management was out of line and struck the plant. It was not a successful strike and strikebreakers were brought in to keep the plant running. Harold doesn't know, but he suspects that some union people falsely reported that the drains had been used for disposing of hazardous materials. Lynn Kuteh (formerly at Gunderson) was the plant manager at the time.

In the mid 1980s, DEQ had put some test stations in various areas of the plant. Later, DEQ representatives came back and took some test samples near the Bell and End Forming Area. They filled a barrel with samples, but never returned to collect it.

Mr. Parrett was at Clackamas when Northwest Pipe bought the L.B. Foster/Beall operation at Burgard. He was in and out of Burgard between 1982 and 1987 when he returned to Burgard as operations supervisor. He worked for John Miller, the then plant manager (same job Randy Ridgley now has) who Bill Tagmyer knows well.

Mr. Miller managed three areas of soil removals. From Area 1, a hole of about 20 feet in diameter and about 12 feet deep was excavated in 1988-1989. Another was from Area 8A. A third was about 3-4 feet from inside the lining and coating building mixing area (this soil was removed and replaced with clean dirt covered with blacktop). These soils initially were "farmed" for about three to four years in an area along the NE Fence line. Later, these soils were hauled away and properly disposed of.

Mr. Parrett reports that the catch basins and storm lines were cleaned twice a year during his tenure as plant supervisor. A company was hired to do the job. It would start at a catch basin and then back flush into the previous catch basin. The material in that catch basin

then would be removed with a hand pump and hauled off-site. The flushing operation would then move to the next down gradient catch basin and do the same thing over again.

Mr. Parrett was supervisor when the 1996 flood occurred. He has no independent recollection of the Xylene spill reported by Northwest Pipe safety officer Cheryl Padilla.

In 1997, the UV system for testing pipe was installed to enable coating of the pipe to help preserve the finish of the pipe coming from #7 ERW mill which is no longer on site.

Mr. Parrett provided several documents (which we returned to him after copies were placed in ProLaw):

1. The Great Northwest Flood, February 1996, LTA Marketing Corporation, 1996 (Exhibit S-24-1.1)

2. Beall Pipe and Tank Corp Brochure, "Steel Pipe," no date (Picture of bays with Beall Pipe and Tank Corp name on them; "the Northwest's largest supplier of welded steel pipe for gas, oil and water transmission and distribution lines," lined and coated steel pipe, "electric fusion steel pipe" ultrasonic and hydrostatic testing, meets standards of the American Petroleum Institute, coal tar enamel and wrap will be applied to customers' specifications, Preliminary cleaning by shot blasting, (see descriptions on Section III, page 4 of shot blasting, coal tar enamel coating, protective wrapping and -- apparently deleted "hot pointer mineral rubber asphalt dipping). See Section III page 6 for description of cement mortar lined and reinforced mortar coated pipe. Welded steel irrigation pipe. Pictures of dipping vat and horizontal application of hot pioneer mineral Rubber Asphalt. (Exhibit S-24-1.2)

3. Beall Pipe and Tank Corp's BPT 10-68 (BPT STD 10-68, Edition Nov. 1968) Specifications and Design Details and Dimensions for Coal-Tar Enamel Lined and Coated Steel Pipe 4" thru 96" (Exhibit S-24-1.3)

4. Beall Pipe and Tank Corp's BPT 11-68 (BPT STD 11-68, Edition Nov. 1968) Specifications and Design Details and Dimensions for Cement Mortar Lined & Coated Steel Pipe 4" thru 48" (Exhibit S-24-1.4)

5. Beall Pipe and Tank Corp's BPT 12-68 (BPT STD 12-68, Edition Nov. 1968) Specifications and Design Details and Dimensions for Cement-Mortar Lined & Coal-Tar Enamel Coated Steel Pipe 4" thru 48" - p. 7: "a. Coal-Tar Primer: The primer shall consisted of processed coal-tar pitch and refined coal-tar oils only, blended to produce a liquid coating which ... will produce an effective boned between the metal and subsequent coating of coal-tar enamel. Primer shall contain no benzol or other toxic, or highly volatile solvents and, no added pigments or inert fibers." (Exhibit S-24-1.5)

6. Flood of 1996 Photo, Northwest Pipe Company bays and portion of International Terminals Slip. Ackroyd Photography, C-8919-2. (Exhibit S-24-1.6)

7. Photograph of Bays 1-6 and 9 and surrounding area while owned by Beall Pipe and Tank Corp. Ackroyd Photography, C-4675-3. (Exhibit S-24-1.6)

8. "Wherever Water Flows Steel Pipes It Best" brochure on steel pipe put out by the Steel Plate Fabricators Association (1955). One steel pipe installation in Portland was installed in 1894 and has 61 years of service. Manufacturing can use one of two types of fusion weld (electric arc welded): a longitudinal weld or a spiral weld; or it can be resistance welded or it can be "cold welded". Bibliography. (Exhibit S-24-1.7)

9. Pipeline Article "Mount St. Helens Update: ...Still Digging Out ..." by Pam Wilkinson (Nov. 1982), describes use of Northwest Pipe and Casing pipe to permit sufficient deflection of quickly rising Spirit Lake, which had been blocked off from its normal drainage into the Toutle River by the eruption. (Exhibit S-24-1.8)

10. Northwest Pipe & Casing article by Pamela Wilkinson Reprint from *Pipeline,* (Dec.1982) a publication of the National Association of Steel Pipe Distributors. 3rd page: "In February of 1982 Northwest Bought Beall from L. B. Foster . . ." 6th page: ". . . at the North Portland Plant, the facilities purchased from Beall are used as a second manufacturing plant. Coating facilities are duplicated with the exception X-Tru coat and powdered epoxy." (Exhibit S-24-1.9)

11. Northwest Pipe Company brochure *Steel Pipe*, (undated). Page 26: "Northwest Pipe Company's Portland facility offers 300,000 square feet of covered space on 20 acres of land. . . . The Portland facility manufactures welded steel pipe in sizes 3" OD through 144" OD with material thickness ranging from 14 gauge through 0.625" inch. (Note from Mr. Parrett: (as of 2010) there are no longer any ERW mills on site.) This facility operates three spiral mills and two straight seam mills. Portland's facility offers all of the linings and coatings described in the coating section of this publication." Page 4: Picture of the transformers and other electrical equipment between two of the bays. Page 26: Picture of the plant showing the sign of the bays: "Northwest Pipe Company." (Exhibit S-24-1.10)

12. 4 page Northwest Pipe brochure (undated). Picture with "Northwest Pipe & Casing Co." sign on the bays. (Exhibit S-24-1.11)

EXHIBIT S-24-1.1

Greater Portland, Oregon Area

The Great Northwest

Flood

February
1996

NWP0032871

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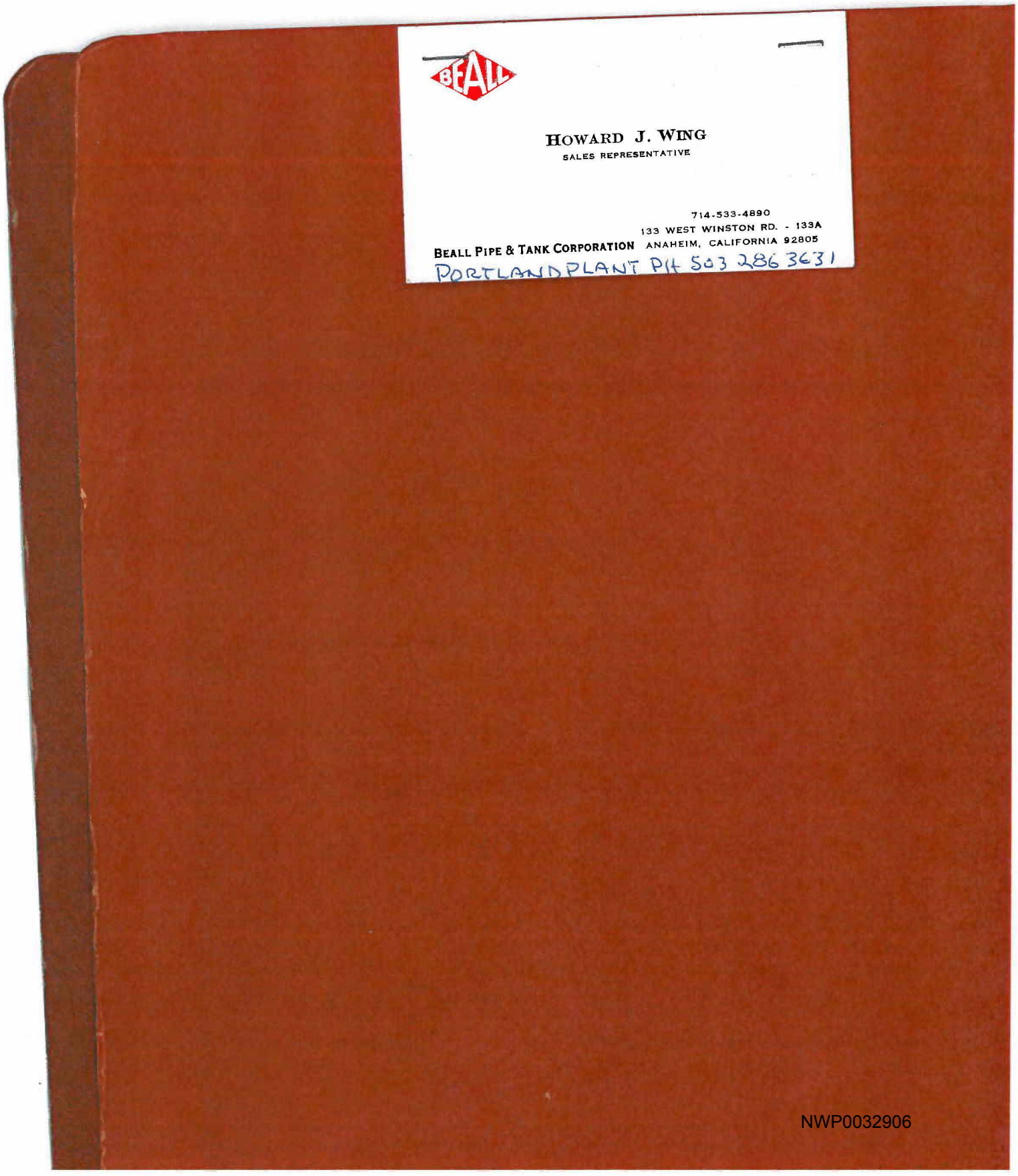
EXHIBIT S-24-1.2

BEALL PIPE AND TANK CORP.

12005 N. BURGARD STREET
PORTLAND 3, OREGON

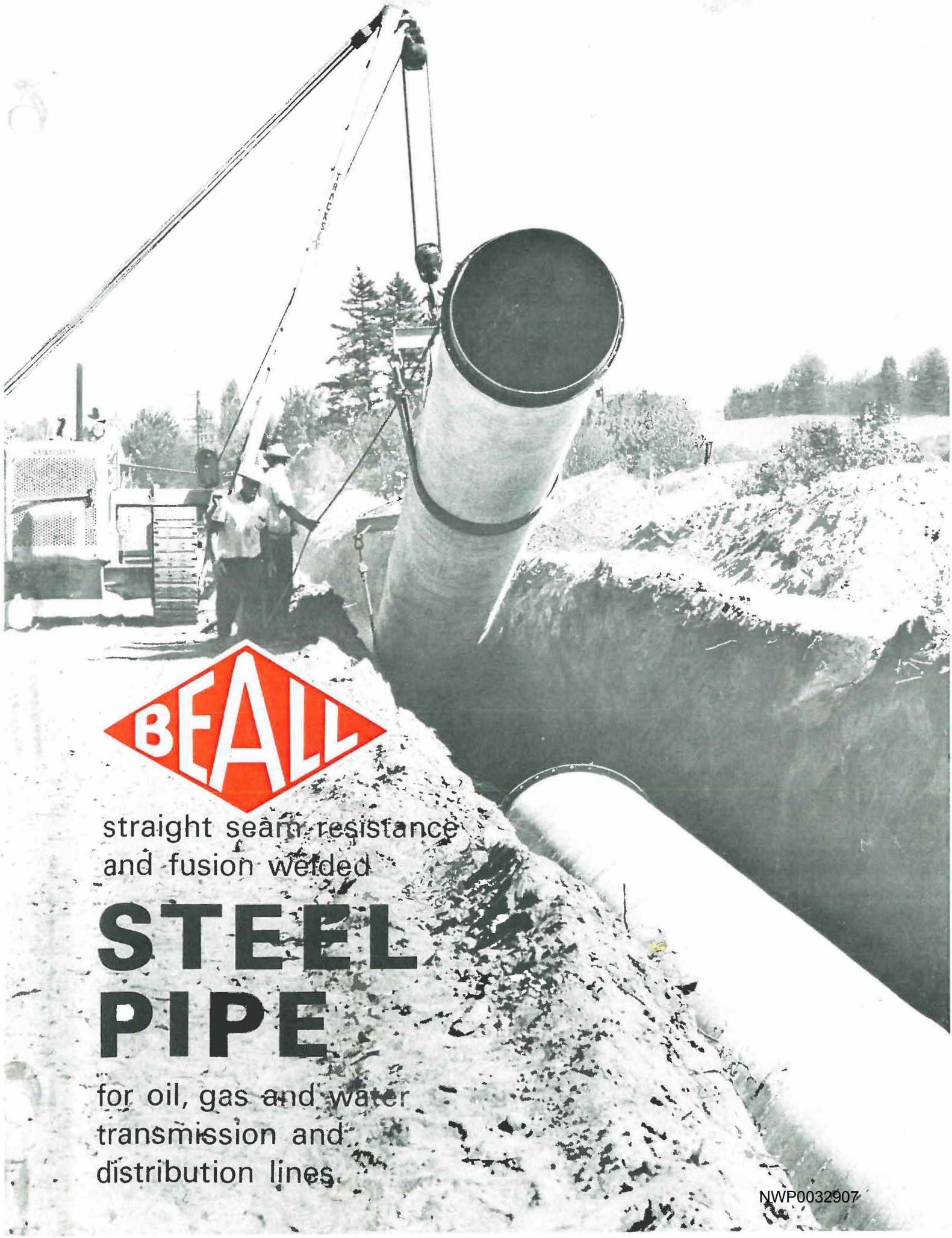
NWP0032905



HOWARD J. WING
SALES REPRESENTATIVE

714-533-4890
133 WEST WINSTON RD. - 133A
BEALL PIPE & TANK CORPORATION ANAHEIM, CALIFORNIA 92805
PORTLAND PLANT Plt 503 286 3631

NWP0032906

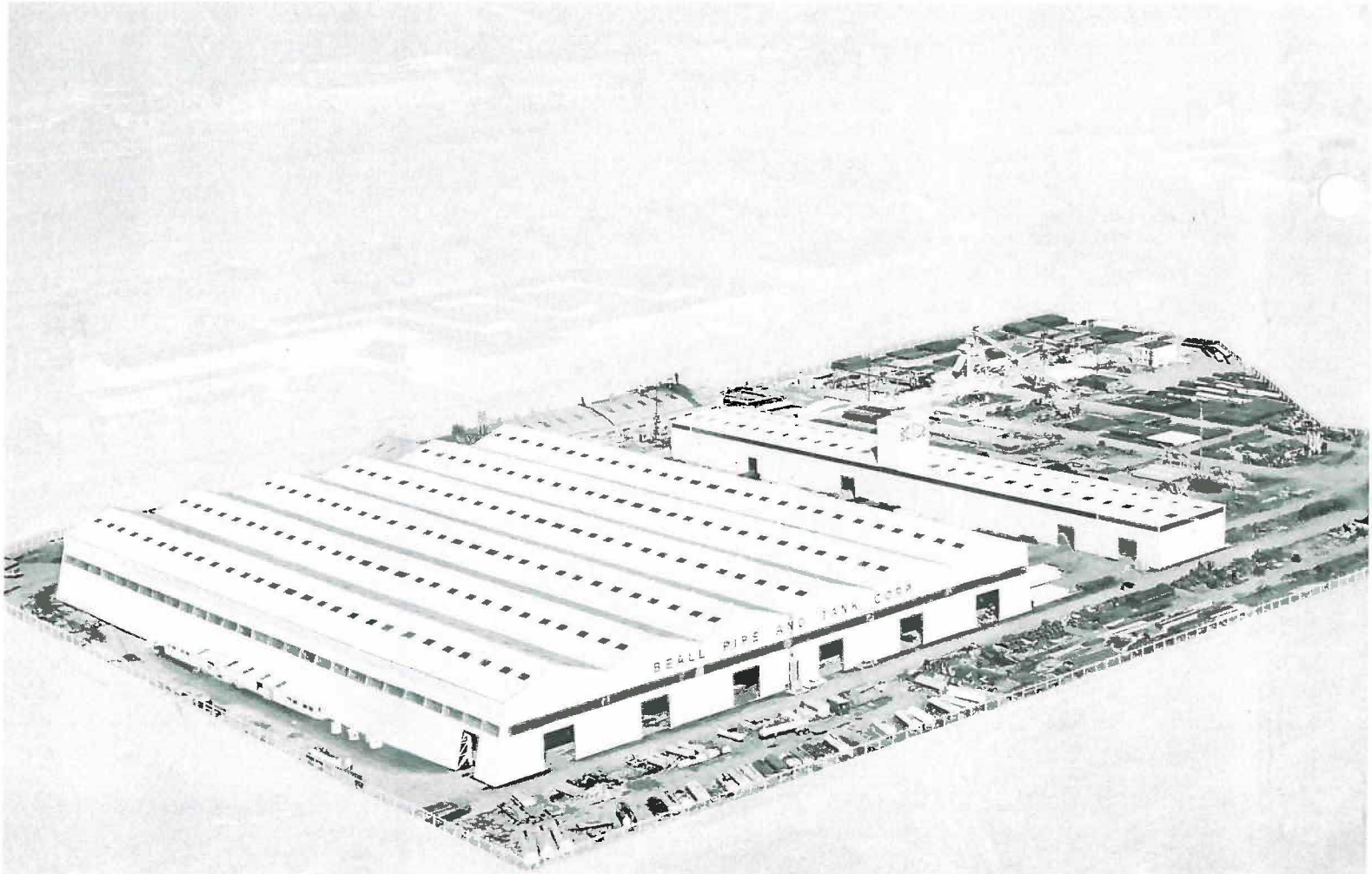


straight seam resistance
and fusion welded

STEEL PIPE

for oil, gas and water
transmission and
distribution lines.

NWP0032907



BEALL

STEEL PIPE CENTER OF THE PACIFIC NORTHWEST

This completely new Beall plant houses the most modern pipe mill equipment available for the manufacture of straight-seam resistance and fusion welded steel pipe.

Here, spread over an area of approximately 25 acres, is an entire facility for producing pipe from flat bare metal to finished specifications: a plant with production capacity of many "miles of pipe per day."

Advanced engineering, fabrication experience, skilled workmanship, precision control and reliable customer service for over 60 years, have made Beall Pipe and Tank Corporation the Northwest's largest supplier of welded steel pipe for gas, oil and water transmission and distribution lines.

LONG AND ECONOMICAL SERVICE LIFE

Beall welded steel pipe is recognized throughout the pipeline industry, and where capacity, strength, ductility and resilience is of importance there is no substitute for Beall pipe. The use of Beall lined and coated steel pipe in transmission and distribution lines adds a durability and economy factor of primary importance.

CONTINUOUS ELECTRIC WELDING JOINS PIPE

Beall straight-seam, electric fusion welded steel pipe is straight, true and of constant diameter. The electrical fusion of pipe metal at the joint creates a perfect bond, produces a weld that is stronger than the pipe itself.

PRECISION CONTROLLED WELDING PRODUCES PIPE TO SPECIFICATIONS

Pipe from 2" to 16" OD is joined by High Frequency Resistance welding. In this process the entire area heated to a point of fusion is held to .006 of an inch on each side of the welded seam.

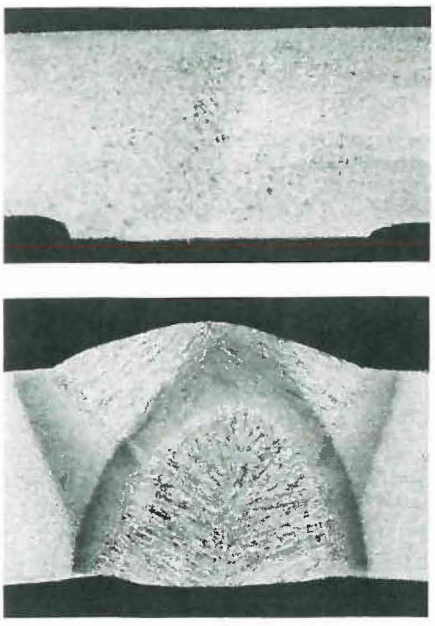
Beall welded steel pipe can be made to meet any of the following specifications:

API	5L	grade A and B
API	5LX	grade X42, X46, X52 and X60
ASTM	A135	grade A and B
ASTM	A120	grade A and B
ASTM	A252	grade 1, 2, or 3
AWWA	C201	

The larger pipe sizes, 18" OD and above, are joined by Electric Fusion welding, and can be made to meet any of the following specifications:

ASTM	A139	grade A and B
API	5L	grade A and B
ASTM	A252	grade 1, 2 and 3
AWWA	C201	

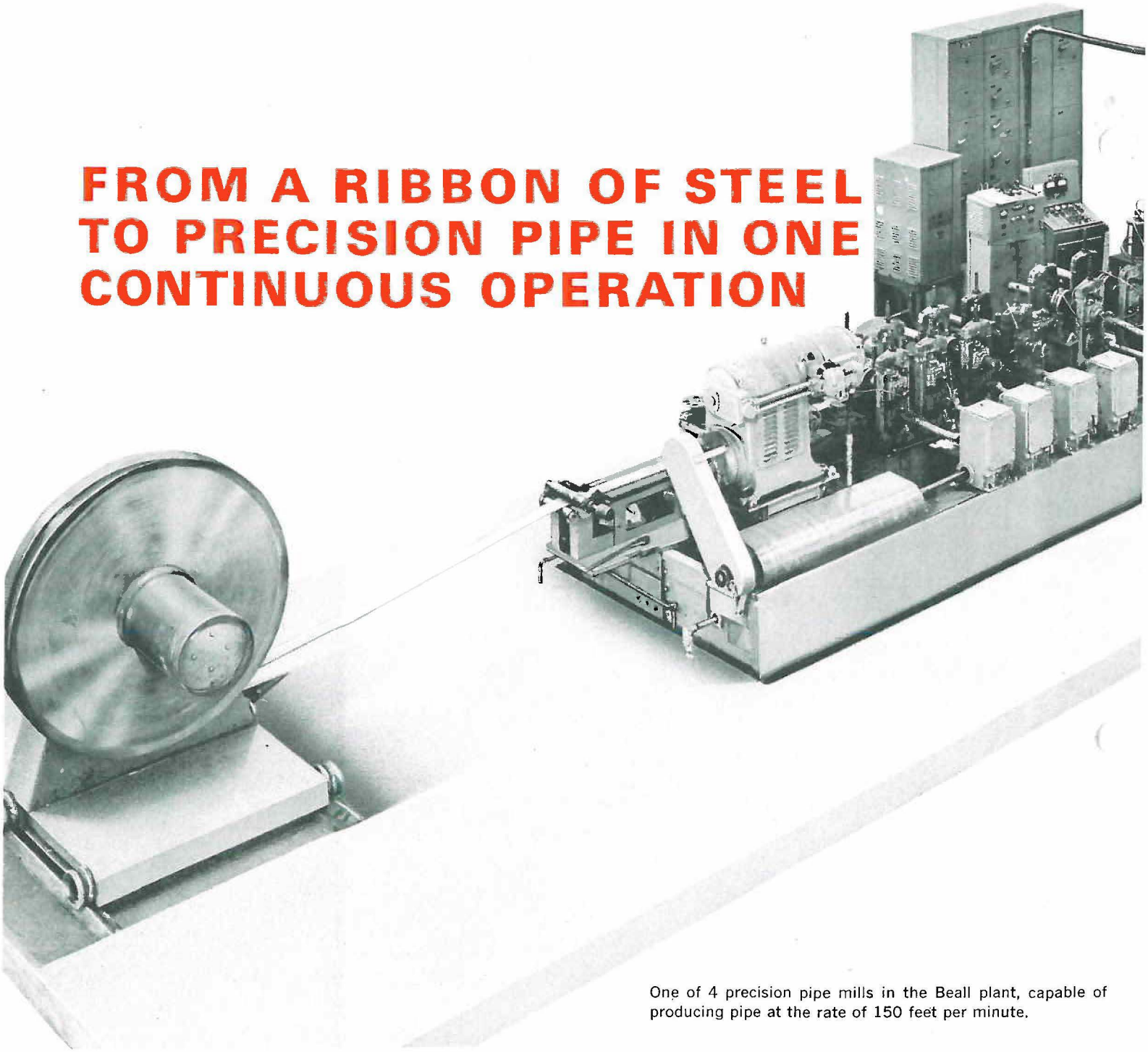
In addition to the specifications shown for large and small diameter pipe, Beall will also make pipe to customers' specifications.



Enlarged unretouched photos show grain structure of weld and adjoining area of Beall pipe.
Above: High Frequency Resistance Weld.
Below: Electric Fusion Weld.

NWP0032909
SECTION I
PAGE

FROM A RIBBON OF STEEL TO PRECISION PIPE IN ONE CONTINUOUS OPERATION



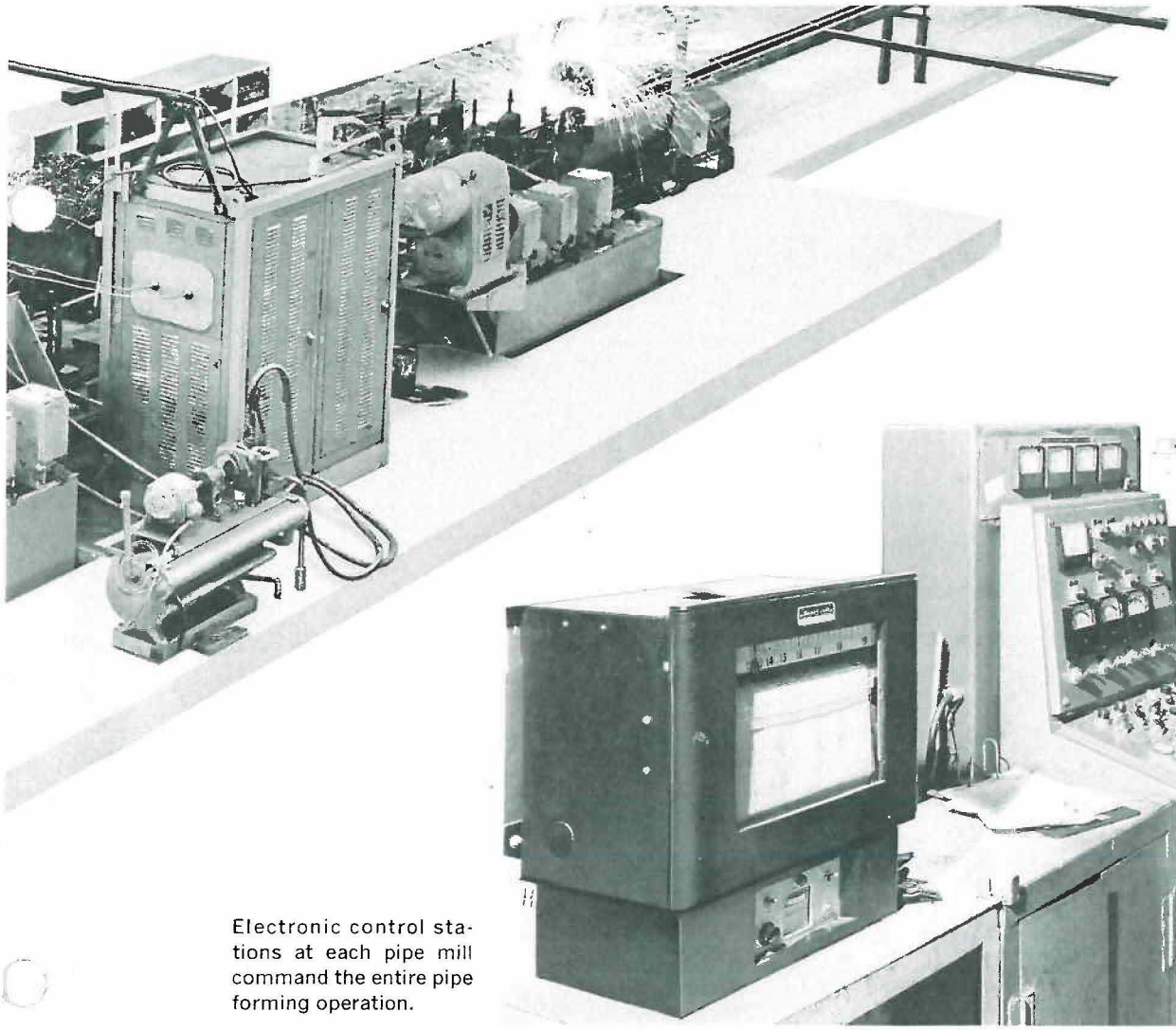
One of 4 precision pipe mills in the Beall plant, capable of producing pipe at the rate of 150 feet per minute.

WIDE RANGE OF SIZES, WEIGHTS AND PROTECTIVE COATINGS FOR ECONOMY AND EXTENDED SERVICE LIFE

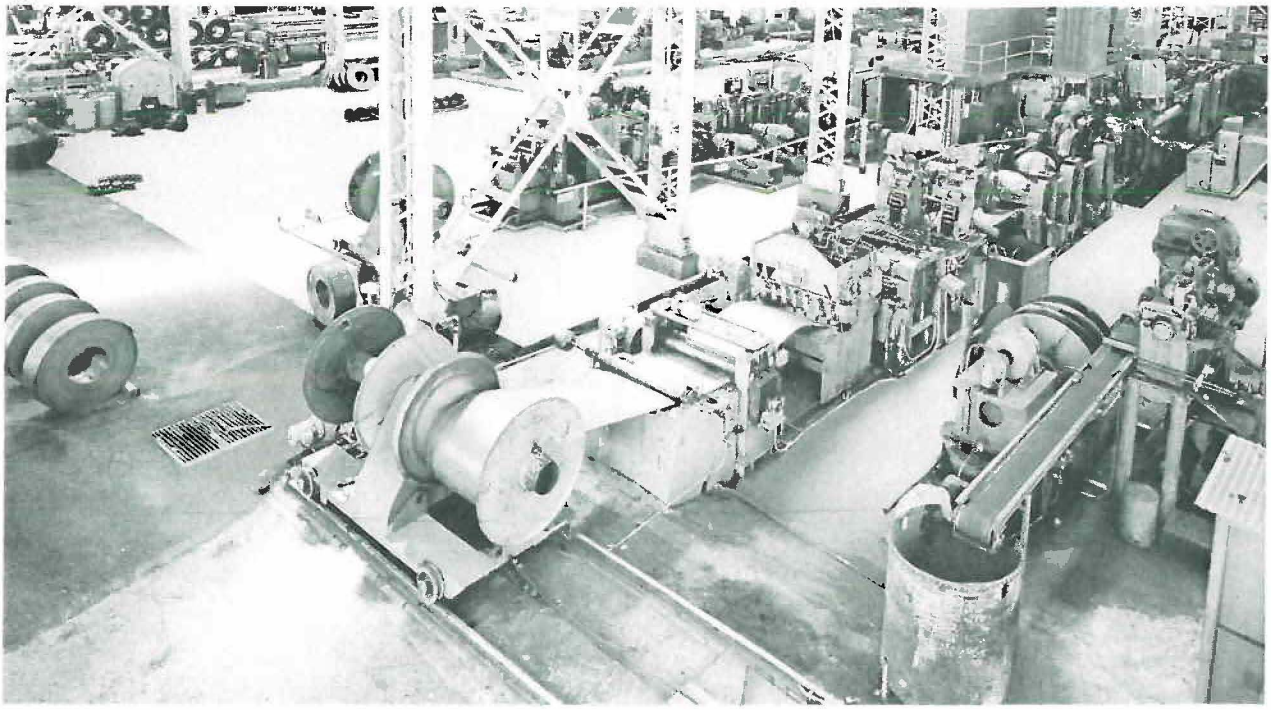
Beall welded pipe is made from special grades of steel (to specifications) in thicknesses of 14 gauge and heavier.

Pipe diameters range from 2″ OD upward and are usually supplied in 40′ lengths. However, on special order, pipe 3″ thru 16″ OD can be furnished in 65′ lengths and pipe of 18″ OD and over can be furnished in 48′ lengths.

The type of protective coating required for your particular installation whether galvanized, coal tar enameled, Pioneer Mineral Rubber Asphalt, dipped and wrapped or cement mortar lined and coated can be supplied to specifications. The application of all protective coatings is subject to Beall's continuous precision control for longer life.



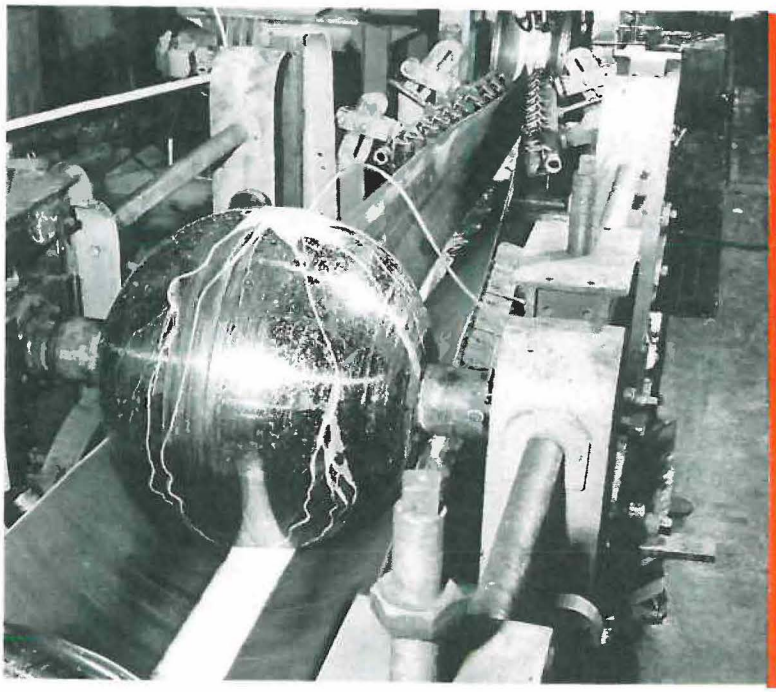
Electronic control stations at each pipe mill command the entire pipe forming operation.

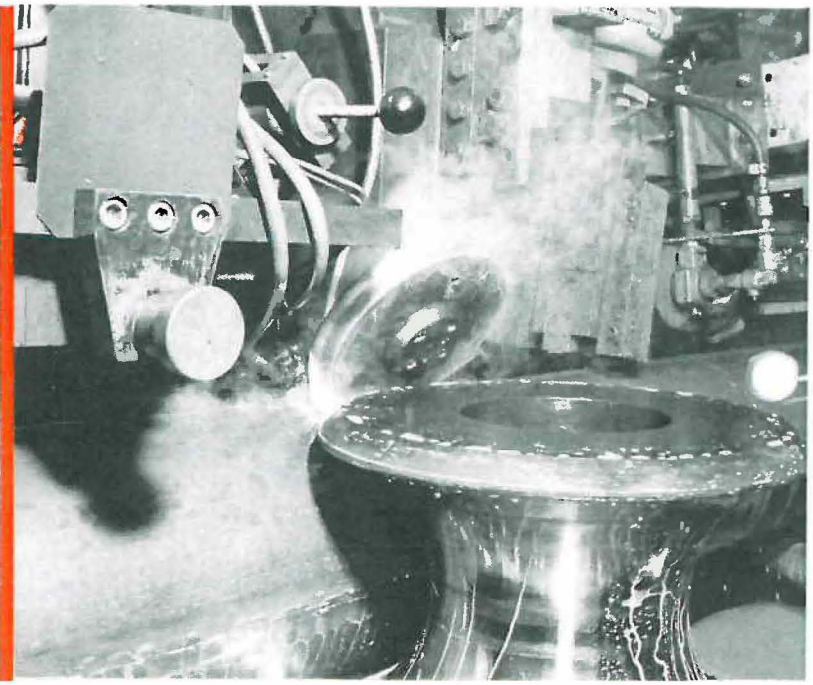


High speed pipe mills in Beall Portland plant.

PRECISION CONTROL

...your assurance of highest quality and pipe performance





PIPE FORMING

As the steel plate is uncoiled it passes between a series of hardened steel forming rollers. These rollers, exerting pressures as much as 200 tons, progressively press and form the steel strip into full round pipe of predetermined diameter.

HIGH FREQUENCY WELDING

At the moment the edges of the strip make contact with each other to form a tube, they pass into the path of the high frequency electrical resistance, which having been converted into heat actually melts and fuses the two edges together.

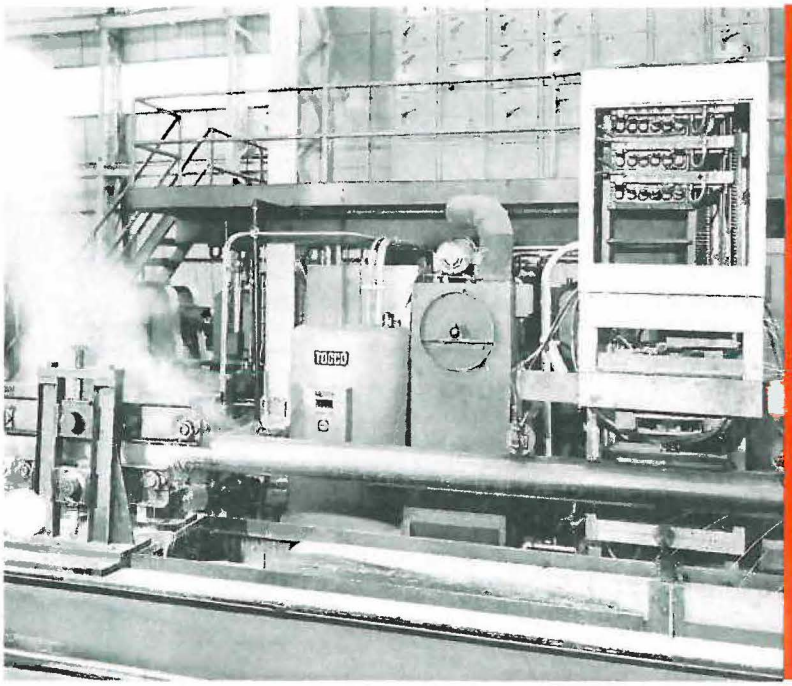
NWP0032912

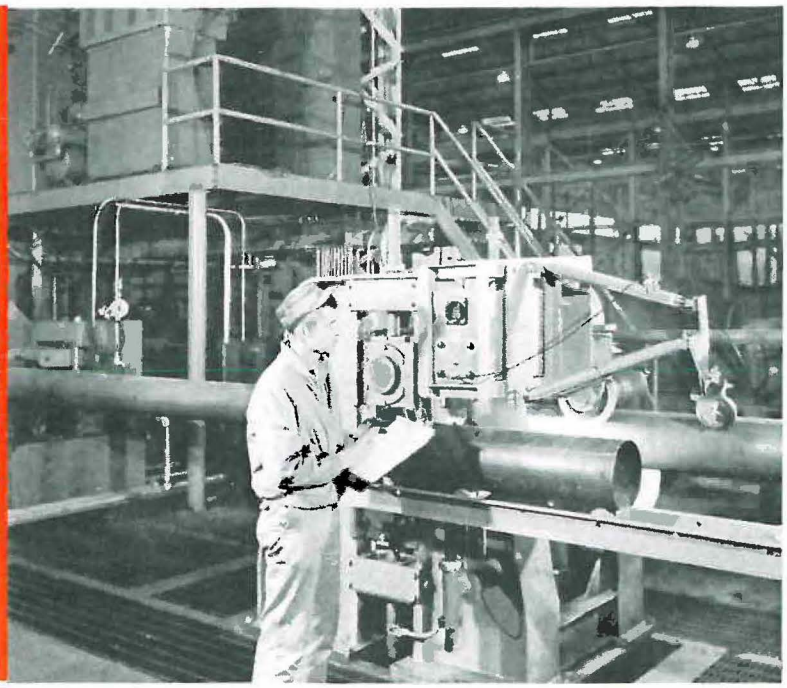
ANNEALING

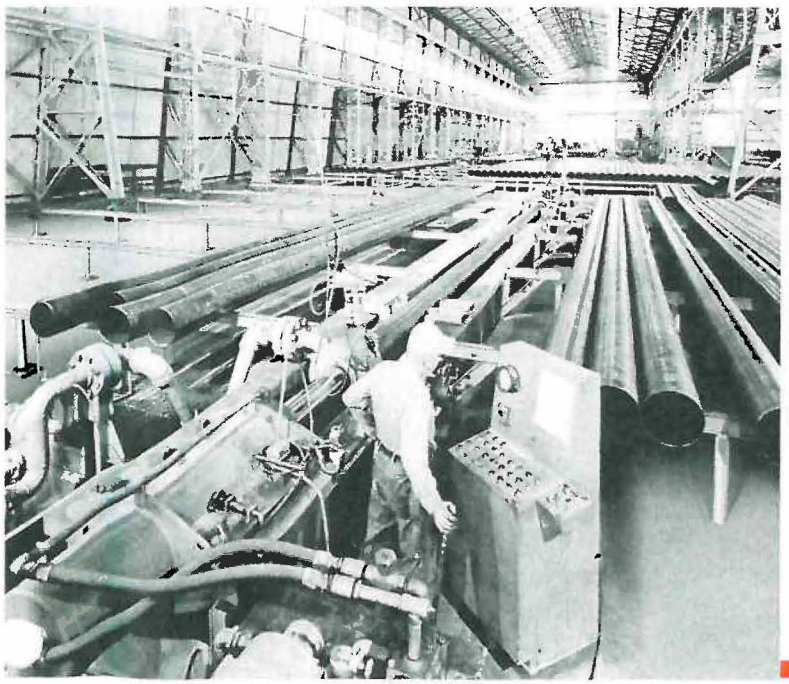
After welding, all API pipe and special drawing quality tubing is post annealed in the weld area, to relieve possible weld and forming stresses. Other grades are post annealed when specified.

ULTRA SONIC TESTING

Ultra sonic inspection for hidden defects, when specified, is done after the pipe has been welded. This testing is done by high speed ultra sonic testing equipment capable of detecting the most minute flaws in the pipe or the weld, thus maintaining quality control at high rate of production.





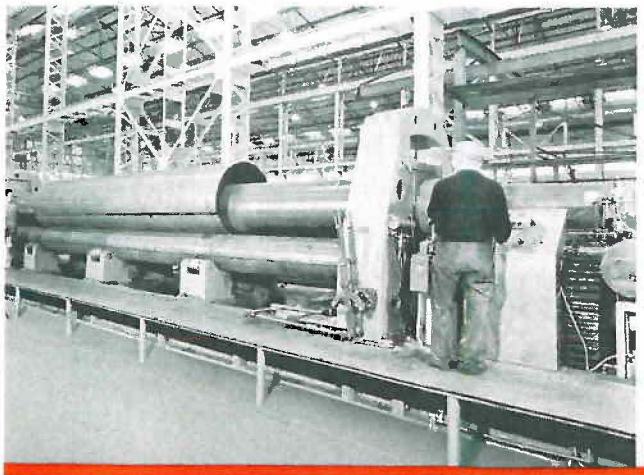


HYDROSTATIC TESTING

In addition to the periodic laboratory spot sampling and destructive testing for quality and adherence to specifications, each length of Beall Pipe is tested hydrostatically. Hydrostatic testing and inspection is done in accordance with API 5L, API 5LX, AWWA, ASTM, FEDERAL and MILITARY specifications as required.

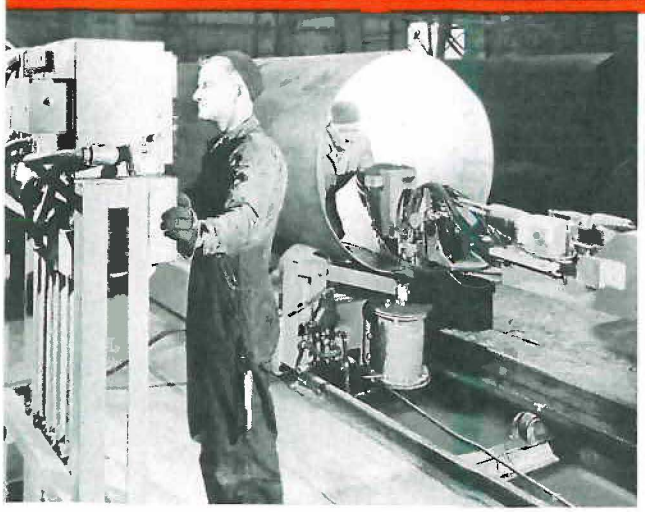
LARGE DIAMETER PIPE

Large diameter and heavy wall pipe is available for any installation. These larger sizes are roll formed to specifications and are subjected to the same quality and precision control and testing procedures of all pipe manufactured by Beall.



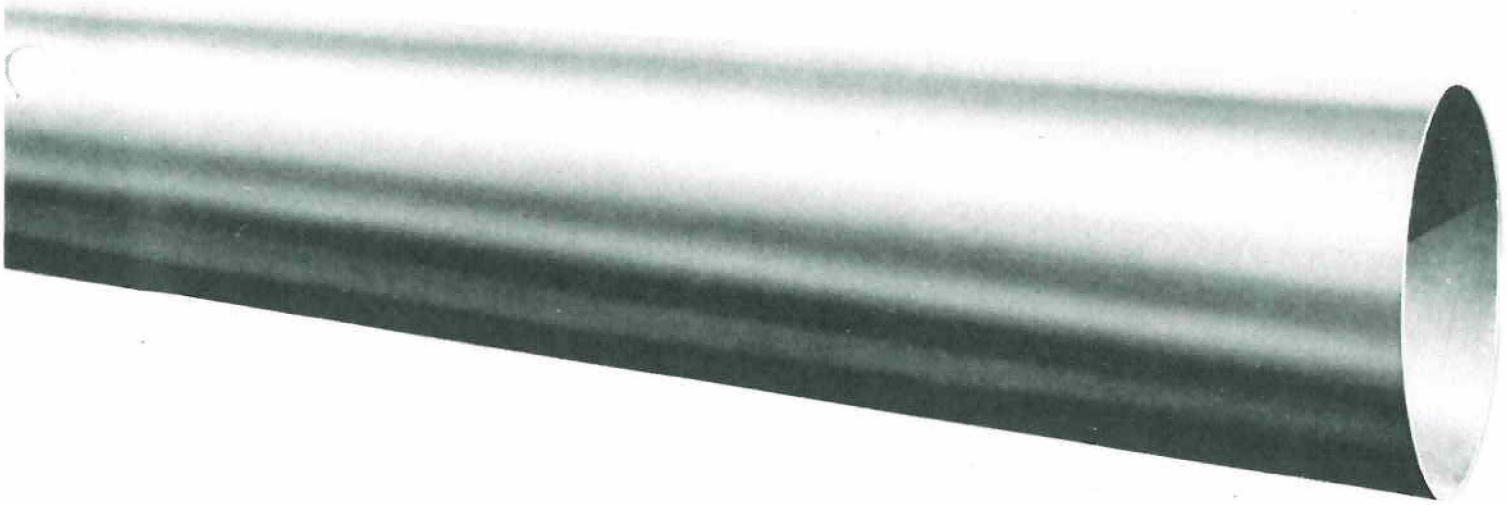
FORMING LARGE PIPE

Large diameter heavy wall pipe being rolled to shape on giant pyramid forming rolls. Pipe sizes above 16″ OD are formed on this equipment. Lengths of 40′ and 48′ are normal for these larger sizes, however, longer lengths are available upon request.



WELDING LARGE PIPE

After being roll formed, the preformed shell is then electric fusion welded. Special fixtures and controls regulate this automatic straight-line weld with precision and accuracy.



BEALL API PIPE

for oil, gas, product transmission lines

Beall is one of the few pipe manufacturers in the country authorized to use the A.P.I. monogram on A.P.I. Std. 5L line pipe and A.P.I. Std. 5LX high test line pipe.

Beall pipe is a non-expanded post annealed high frequency electric resistance welded steel pipe, conforming in all respects to A.P.I. 5L or A.P.I. 5LX specifications.

Extreme care is taken by Beall in the manufacture and inspection of A.P.I. pipe to maintain a high quality product in line with the standards set by the American Petroleum Institute.

Beall straight seam welded steel pipe is manufactured to meet any of the following specifications:

API 5L grade A and B
—sizes 3″ nom. to 16″ OD

API 5LX grade X42, X46, X52 and X60
—sizes 6″ to 16″ OD

A full range of sizes and gauges as shown on the following chart is available as are special sizes. Ultra sonic inspection is made on all Beall pipe when specified. Coatings and end finishes are furnished to specifications.

API PIPE

API STANDARD 5L

REGULAR-WEIGHT PLAIN END LINE PIPE

Dimensions, Weights and Test Pressures

Size O.D. (Inches)	Plain-End Weight (lb./ft.)	Wall Thickness (inches)	I.D. (Inches)	Test Pressures (P.S.I.) Grade A	Grade B
3½	6.63	0.188	3.124	1900	2200
3½	7.58	0.216	3.068	2200	2500
3½	8.68	0.250	3.000	2500	2500
4½	8.64	0.188	4.124	1500	1800
4½	10.00	0.219	4.062	1700	2000
4½	10.79	0.237	4.026	1900	2200
4½	11.35	0.250	4.000	2000	2300
4½	12.67	0.281	3.938	2200	2500
6⅝	12.89	0.188	6.249	1000	1200
6⅝	14.97	0.219	6.187	1200	1400
6⅝	17.02	0.250	6.125	1400	1600
6⅝	18.97	0.280	6.065	1500	1800
6⅝	21.07	0.312	6.001	1700	2000
8⅝	16.90	0.188	8.249	800	900
8⅝	19.64	0.219	8.187	900	1100
8⅝	22.36	0.250	8.125	1000	1200
8⅝	24.70	0.277	8.071	1200	1300
8⅝	27.74	0.312	8.001	1300	1500
10¾	24.60	0.219	10.312	750	850
10¾	28.04	0.250	10.250	850	1000
10¾	31.20	0.279	10.192	1000	1200
10¾	34.24	0.307	10.136	1000	1200
12¾	33.38	0.250	12.250	700	800
12¾	37.45	0.281	12.188	800	950
12¾	41.51	0.312	12.126	900	1000
14	45.68	0.312	13.376	800	950
16	52.36	0.312	15.376	700	800

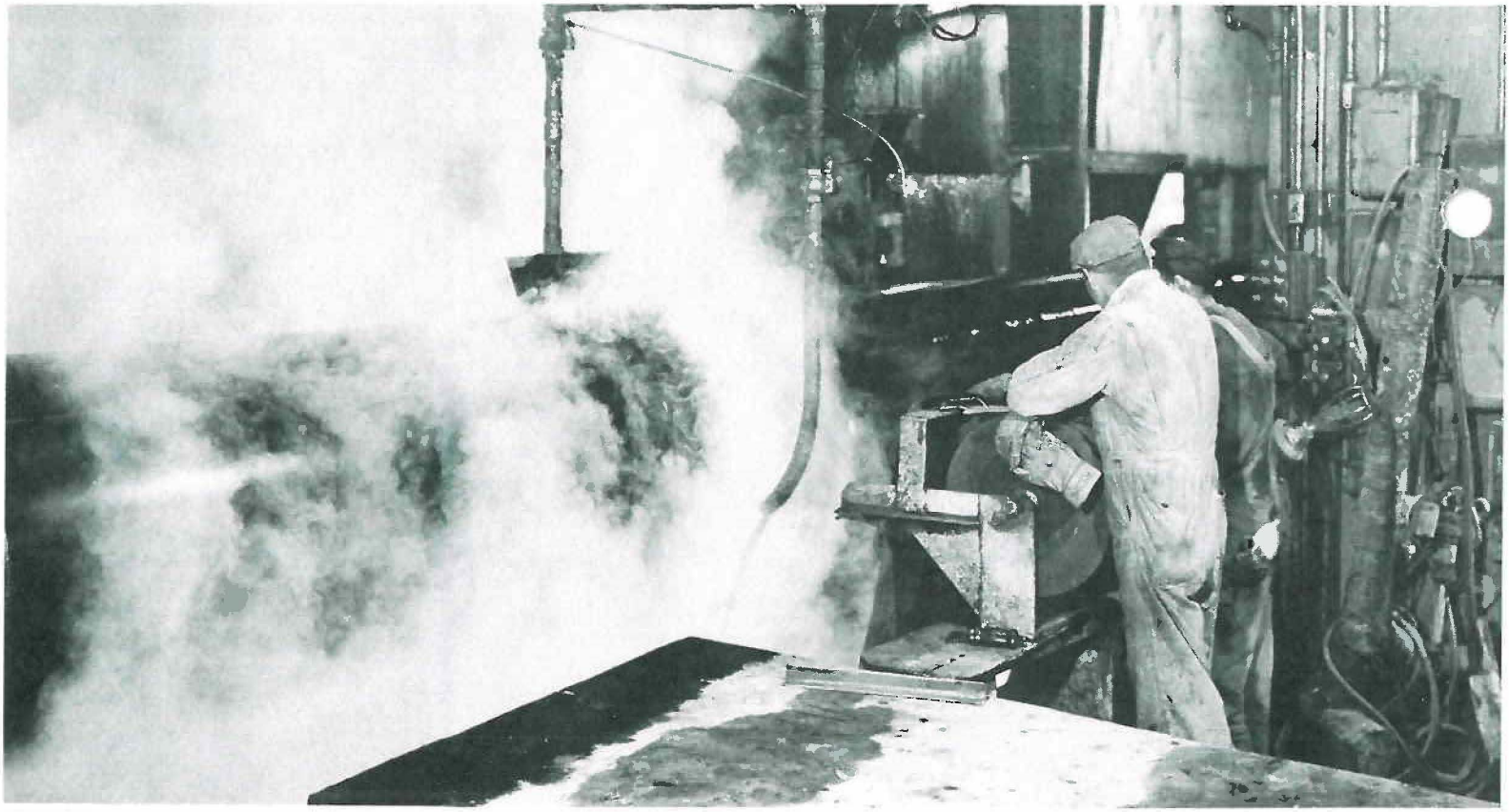
NWP0032916

API PIPE

API STANDARD 5LX
HIGH-TEST PLAIN END LINE PIPE

Dimensions, Weights and Test Pressures

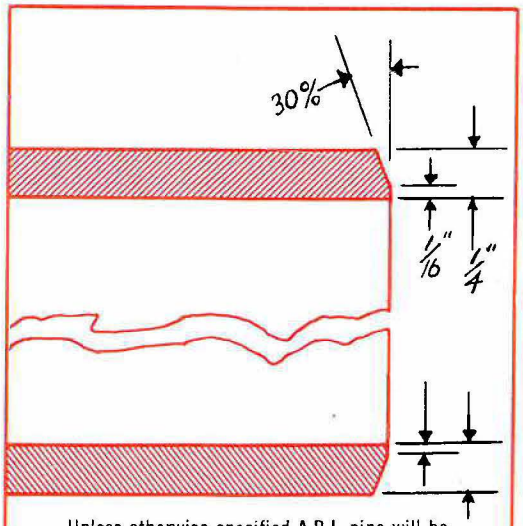
Size O.D. (Inches)	Weight (lb./ft.)	Wall Thickness (Inches)	Size I.D. (Inches)	Test Pressures (P.S.I.)		
				Grade X42	Grade X46	Grade X52
6⅝	12.89	0.188	6.249	1790	1960	2220
6⅝	14.97	0.219	6.187	2090	2290	2580
6⅝	17.02	0.250	6.125	2380	2610	2950
6⅝	18.97	0.280	6.065	2670	2920	3000
6⅝	21.07	0.312	6.001	2970	3000	3000
8⅝	16.90	0.188	8.249	1380	1510	1710
8⅝	18.27	0.203	8.219	1490	1630	1840
8⅝	19.64	0.219	8.187	1600	1760	1990
8⅝	22.36	0.250	8.125	1830	2010	2270
8⅝	24.70	0.277	8.071	2030	2220	2510
8⅝	27.74	0.312	8.001	2280	2500	2830
10¾	21.15	0.188	10.374	1250	1370	1550
10¾	22.88	0.203	10.344	1350	1480	1670
10¾	24.60	0.219	10.312	1460	1600	1810
10¾	28.04	0.250	10.250	1670	1820	2060
10¾	31.20	0.279	10.192	1860	2030	2300
10¾	34.24	0.307	10.136	2040	2240	2530
12¾	27.22	0.203	12.344	1140	1250	1410
12¾	29.28	0.219	12.312	1230	1350	1520
12¾	33.38	0.250	12.250	1410	1540	1740
12¾	37.45	0.281	12.188	1580	1730	1950
12¾	41.51	0.312	12.126	1750	1920	2170
14	30.93	0.210	13.580	1080	1180	1330
14	32.20	0.219	13.562	1120	1230	1390
14	36.71	0.250	13.500	1280	1400	1580
14	41.21	0.281	13.438	1440	1570	1780
14	45.68	0.312	13.376	1600	1750	1980
16	36.87	0.219	15.562	980	1080	1220
16	42.05	0.250	15.500	1120	1230	1390
16	47.22	0.281	15.438	1260	1380	1560
16	52.36	0.312	15.376	1400	1530	1730



Coal tar enamel and wrap will be applied to the outside of Beall API Pipe to the customers' specifications.

API PIPE COATING

The protective finishes applied to Beall pipe are subject to the same rigid quality control exercised in the manufacture of the pipe. Thorough preliminary cleaning by shot blasting assures proper bonding of the coating. Final inspection is made by ultra sonic thickness testing gauges and electric spark gap testing equipment.



Unless otherwise specified A.P.I. pipe will be furnished with plain ends, which is an end beveled to an angle of 30°, +5° to −0°, measured from a line drawn perpendicular to the axis of the pipe and with a root face of 1/16" ± 1/32".

BEALL

PIPE & TANK CORP.

PORTLAND OFFICE
12005 N. Burgard, Portland 3, Oregon
Phone AVenue 6-3631

PLANTS ALSO AT:

218 N. 16th St., Billings, Mont., Phone 252-7163	225 Broadway, Boise, Ida., Phone 344-3561	5701 Colorado Blvd., Denver, Colo., Phone AT 8-0739	7001 San Leandro St., Oakland, Calif., Phone 569-0903

SALES OFFICES ALSO AT: Seattle • Spokane • Eugene • Klamath Falls

NWP0032918

BEALL AWWA ASTM PIPE

for water transmission and sewer lines

Beall straight seam welded steel pipe is manufactured to meet any of the following specifications:

sizes 2″ to 16″ OD
AWWA C201 and C202
ASTM A135 grade A and B
ASTM A120 grade A and B
ASTM A252 grade A and B

sizes above 16″ OD
AWWA C201 and C202
ASTM A130 grade A and B
ASTM A252 grade A and B

A full range of sizes and gauges as shown on the following chart is available, as are special sizes. Coatings, end finishes and connectors are furnished to specifications.

NWP0032919

BEALL AWWA

O.D. (Inches)	Wall Thickness		I.D. (Inches)	Weight (Bare) lb./ft.	Test Pressure P.S.I.	Head	Working Pressure (12,500 P.S.I.)
	Decimal	Gage or Fraction					
2	.060	16	1.88	1.3	1120	1725	747
2	.075	14	1.85	1.5	1400	2154	933
2	.105	12	1.79	2.1	1960	3018	1307
2	.134	10	1.73	2.7	2520	3882	1681
2-3/8	.060	16	2.26	1.7	940	1450	628
2-3/8	.075	14	2.23	1.9	1175	1810	784
2-3/8	.105	12	2.17	2.7	1645	2536	1098
2-3/8	.134	10	2.11	3.4	2120	3264	1413
3	.060	16	2.88	2.0	750	1150	498
3	.075	14	2.85	2.5	930	1436	622
3	.105	12	2.79	3.4	1310	2011	871
3	.134	10	2.73	4.4	1680	2588	1121
3-1/2	.060	16	3.38	2.3	640	986	427
3-1/2	.075	14	3.35	2.9	800	1230	533
3-1/2	.105	12	3.29	4.0	1115	1725	747
3-1/2	.134	10	3.23	5.1	1480	2284	989
4	.060	16	3.88	2.7	565	870	375
4	.075	14	3.85	3.2	765	1175	510
4	.105	12	3.79	4.5	975	1500	650
4	.134	10	3.73	5.7	1260	1935	840
4-1/2	.075	14	4.35	3.6	630	965	420
4-1/2	.105	12	4.29	5.0	850	1345	565
4-1/2	.134	10	4.23	6.4	1115	1720	745
4-1/2	.188	3/16"	4.13	8.7	1540	2420	1025
5	.075	14	4.85	4.2	565	870	375
5	.105	12	4.79	5.7	790	1210	525
5	.134	10	4.73	7.3	1000	1550	670
5	.188	3/16"	4.63	10.1	1410	2175	940
6	.075	14	5.85	4.9	475	735	315
6	.105	12	5.79	6.7	670	1030	445
6	.134	10	5.73	8.6	865	1325	575
6	.188	3/16"	5.63	12.1	1150	1775	770
6-5/8	.075	14	6.47	5.4	430	655	285
6-5/8	.105	12	6.42	7.5	600	920	400
6-5/8	.134	10	6.36	9.6	760	1165	505
6-5/8	.188	3/16"	6.25	13.0	1065	1640	710
8	.075	14	7.85	6.5	355	550	235
8	.105	12	7.79	9.0	490	775	335
8	.134	10	7.73	11.6	645	1000	430
8	.188	3/16"	7.63	16.1	880	1350	585
8-5/8	.105	12	8.42	9.8	465	705	310
8-5/8	.134	10	8.36	12.5	585	900	390
8-5/8	.188	3/16"	8.25	17.4	820	1260	545
8-5/8	.250	1/4"	8.13	22.4	1090	1680	725
10	.105	12	9.79	11.3	400	620	265
10	.134	10	9.73	14.5	520	795	345
10	.188	3/16"	9.62	20.2	700	1080	465
10	.250	1/4"	9.50	26.0	940	1440	625
10-3/4	.105	12	10.54	12.2	370	565	245
10-3/4	.134	10	10.48	15.6	465	715	310
10-3/4	.188	3/16"	10.37	21.7	650	1000	435
10-3/4	.250	1/4"	10.25	28.0	870	1335	580
12	.105	12	11.79	13.6	330	515	220
12	.134	10	11.73	17.5	430	660	285
12	.188	3/16"	11.63	24.3	590	900	390
12	.250	1/4"	11.50	31.4	780	1200	520
12-3/4	.105	12	12.54	14.5	320	480	210
12-3/4	.134	10	12.48	18.6	400	610	265
12-3/4	.188	3/16	12.37	25.9	555	855	370
12-3/4	.250	1/4"	12.25	33.4	735	1135	490
12-3/4	.312	5/16"	12.22	41.5	920	1415	615

NWP0032920

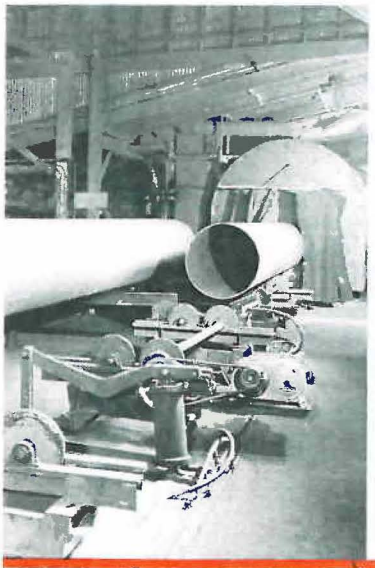
ASTM PIPE

O.D. (Inches)	Wall Thickness		I.D. (Inches)	Weight (Bare) lb./ft.	Test Pressure P.S.I.	Head	Working Pressure (12,500 P.S.I.)
	Decimal	Gage or Fraction					
14	.105	12	13.79	15.9	285	440	190
14	.134	10	13.73	20.4	370	565	245
14	.188	3/16″	13.63	28.4	505	775	335
14	.250	1/4″	13.50	36.7	670	1030	445
14	.312	5/16″	13.38	45.7	835	1285	555
16	.134	10	15.73	23.4	325	495	215
16	.188	3/16″	15.63	32.6	435	675	290
16	.250	1/4″	15.50	42.1	585	900	390
16	.312	5/16″	15.38	52.4	730	1125	485
18	.134	10	17.73	26.3	285	440	190
18	.188	3/16″	17.63	36.7	390	600	260
18	.250	1/4″	17.50	47.4	520	800	345
18	.312	5/16″	17.38	59.0	645	1000	430
20	.134	10	19.73	29.2	255	395	170
20	.188	3/16″	19.63	40.8	355	540	235
20	.250	1/4″	19.50	52.7	465	720	310
20	.312	5/16″	19.38	65.7	585	900	390
22	.134	10	21.73	32.2	235	360	155
22	.188	3/16″	21.63	44.9	315	490	210
22	.250	1/4″	21.50	58.1	430	655	285
22	.312	5/16″	21.38	72.4	525	815	350
24	.188	3/16″	23.63	49.0	295	450	195
24	.250	1/4″	23.50	63.4	390	600	260
24	.312	5/16″	23.38	79.1	490	750	325
24	.375	3/8″	23.25	100.3	585	905	390
26	.188	3/16″	25.63	54.0	270	415	180
26	.250	1/4″	25.50	71.6	360	555	240
26	.312	5/16″	25.38	90.5	450	690	300
26	.375	3/8″	25.25	106.7	540	835	360
28	.188	3/16″	27.63	58.9	255	390	170
28	.250	1/4″	27.50	79.1	340	515	225
28	.312	5/16″	27.38	99.7	435	645	280
28	.315	3/8″	27.25	118.9	505	775	335
30	.188	3/16″	29.63	62.3	235	360	155
30	.250	1/4″	29.50	82.6	310	480	205
30	.312	5/16″	29.38	104.5	390	600	260
30	.375	3/8″	29.25	125.4	465	720	310
32	.188	3/16″	31.63	68.8	225	340	150
32	.250	1/4″	31.50	91.7	295	450	195
32	.312	5/16″	31.38	114.3	370	565	245
32	.375	3/8″	31.25	137.9	445	680	295
34	.188	3/16″	33.63	73.7	210	320	140
34	.250	1/4″	33.50	97.8	280	425	185
34	.312	5/16″	33.38	122.6	345	530	230
34	.375	3/8″	31.25	147.9	420	645	280
36	.188	3/16″	35.63	74.7	195	300	130
36	.250	1/4″	35.50	99.2	255	400	170
36	.312	5/16″	35.38	125.4	325	500	215
36	.375	3/8″	35.25	150.6	390	600	260
42	.250	1/4″	41.50	116.5	225	345	150
42	.312	5/16″	41.38	147.4	280	430	185
42	.375	3/8″	41.25	177.0	330	515	220
48	.250	1/4″	47.50	133.0	195	300	130
48	.312	5/16″	47.38	168.3	240	375	160
48	.375	3/8″	47.25	202.2	295	450	195
54	.312	5/16″	53.38	189.1	220	335	145
54	.375	3/8″	53.25	227.3	265	400	175
60	.312	5/16″	59.38	207.8	195	300	130
60	.375	3/8″	59.25	249.8	235	360	155

PROTECTIVE COATINGS EXTEND PIPE SERVICE LIFE

Beall pipe is available in a variety as well as a combination of linings and coatings to meet all specifications for varying service conditions. These protective coatings are applied under rigidly controlled conditions. Inspection is made with thickness gauges and electric spark gap testing equipment to assure complete coverage and adequate coating thickness.

In addition to the various applied coatings, Beall high frequency resistance welded pipe can be furnished in 14, 12, or 10 gauge cold rolled galvanized with hot zinc coating at the weld. This completely protected galvanized water pipe is supplied in sizes 2⅜" OD to 16" OD.

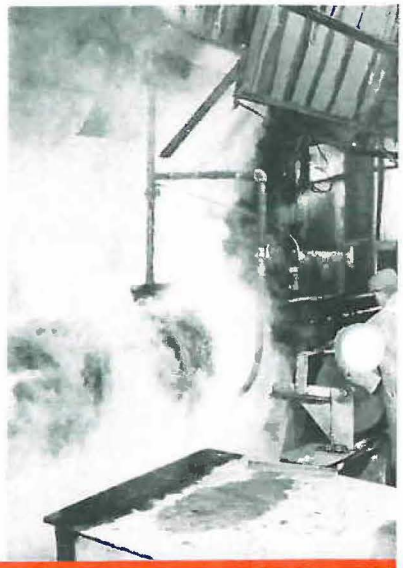


SHOT BLASTING

Each length of pipe, prior to coating, with coal tar enamel, is shot blasted. By this process, all foreign matter, including rust and mill scale, is removed from the surface to be coated. This cleaning and smoothing operation imparts a finish to the pipe which is highly receptive to the coatings.

COAL TAR ENAMEL COATING

The shot blasting, priming with coal tar primer, and enameling with coal tar enamel is done in accordance with A.W.W.A. specifications. After the enamel has cooled, it is tested by an electric spark gap machine to assure perfect protection to the steel pipe. This coating is the *finest* protective lining and coating available.

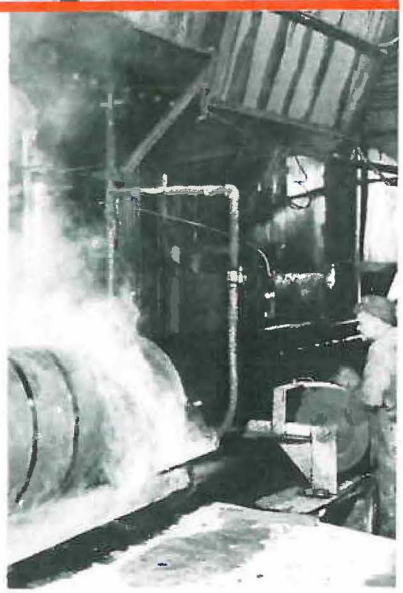


HOT PIONEER MINERAL RUBBER ASPHALT DIPPING

Pipe in lengths up to 48′ can be dipped in superheated Pioneer Mineral Rubber Asphalt in Beall's vertical dipping vat. Pre-heated for proper bonding, pipe coated with P.M.R., a Gilsonite product, is protected with a material having a "service record" unequalled by any other asphaltic material used for similar purposes. This coating is malleable at all temperatures and will not flake or scale in cold weather or drip and run if exposed to the sun's direct rays. The protection is equally complete whether the pipe is exposed to the weather or buried in the soil. P.M.R. coating is odorless and tasteless.

PROTECTIVE WRAPPING

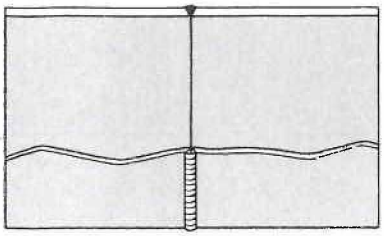
Proper wrapping of the pipe is very important. Beall uses 23½ pound asbestos pipeline felt which is saturated with selected asphalt, or a coal tar wrap which is a 13½ pound asbestos felt impregnated with coal tar. As the asbestos felt is wrapped in a spiral around the pipe at high speed, melted asphalt or coal tar is applied in a continuous flow between the pipe and the wrapping paper, giving lasting protection against corrosion. Other types of wrap are available on request.



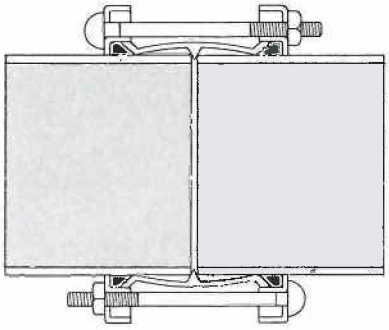
NWP0032922

END FINISHES FOR AWWA AND ASTM PIPE

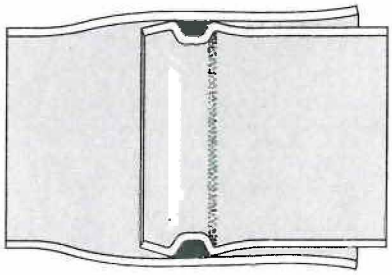
Beall AWWA and ASTM Pipe is available in all of the common end finishes. Ends can be formed or fitted for special connectors.



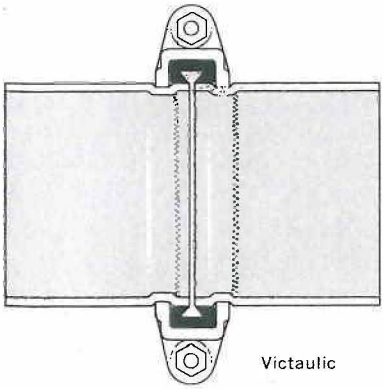
Weld End, Beveled



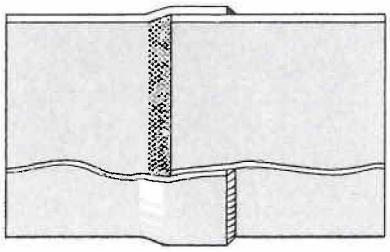
Dresser, Bolted



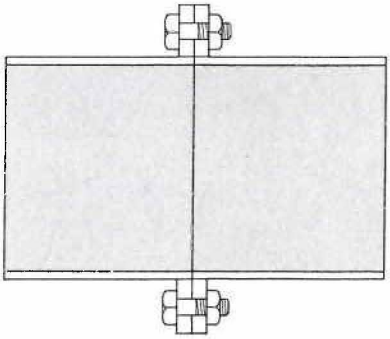
Bell and Spigot, for "O" Ring Gasket



Victaulic



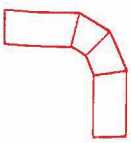
Bell and Spigot, Slip Joint



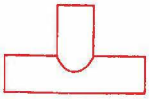
Flanged

FITTINGS FOR AWWA AND ASTM PIPE

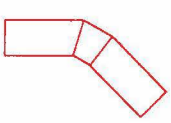
Shop fabricated fittings, in steels to match the pipe and with identical protective coatings can be furnished in all the standard patterns. Regardless of the type of fitting required, any "specials" can be made to specifications.



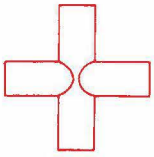
90° Elbow



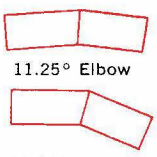
Tee



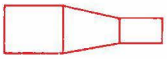
45° Elbow



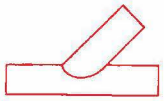
Cross



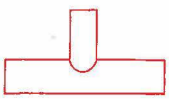
22.5° Elbow



Reducer



Wye



Reducer Tee

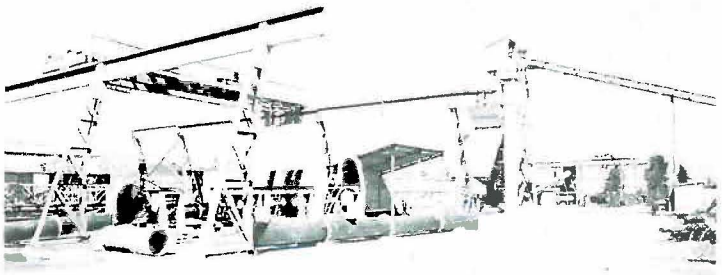
NWP0032923

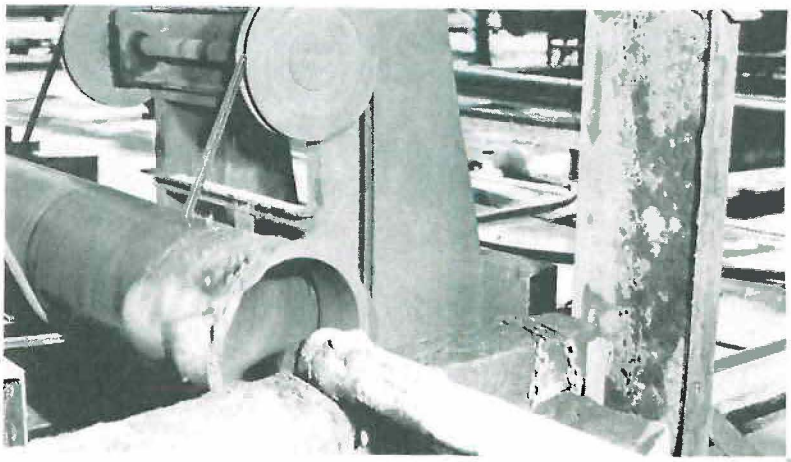
CEMENT MORTAR LINED AND REINFORCED MORTAR COATED PIPE

Meets Federal Interim Specifications SS-P-00385 with design pressures from 100 PSI to 400 PSI

Cement mortar is a dual purpose protective coating. In addition to its corrosion resistance qualities, cement mortar rigidizes and strengthens the pipe. Beall cement mortar lined and reinforced mortar coated pipe is made in lengths to 40 feet with pressure ratings from 100 PSI to 400 PSI. Special sizes and design pressures can be produced as specified.

Care is taken in securing, storing and mixing the components for Beall's cement mortar lined and coated pipe. Only the finest material available is used to produce a lined and coated pipe with unsurpassed qualities. The same quality control is exercised in the application of cement mortar lining and coating as is exercised in forming and other coating processes at the Beall plant.



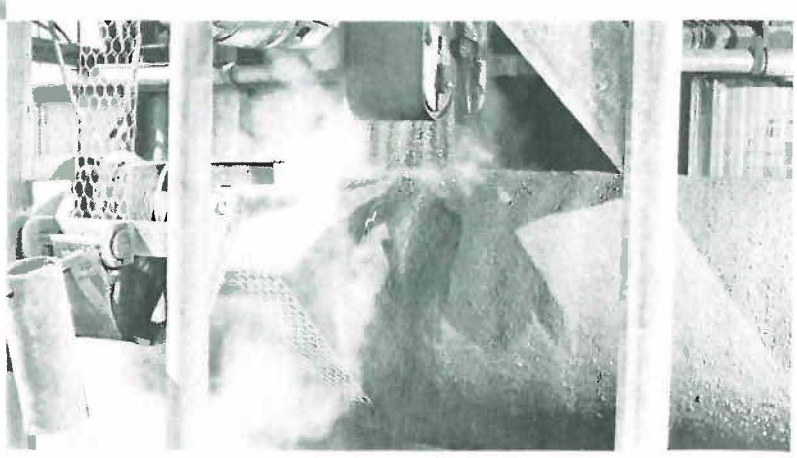


CEMENT MORTAR LINING

After the cement mortar is mixed to established requirements, the lance is thrust into the steel pipe and withdrawn at a pre-determined rate depositing a precise amount of mortar. When the pipe is spun, centrifugal force on the mortar produces a lining which is uniform in thickness, has an excellent bond, is dense, well compacted and smooth.

REINFORCED MORTAR COATING

The reinforced mortar coating is applied in accordance with Interim Federal Specification SS-P-00385 and is applied to the exterior of the rotating pipe by high pressure spray. Wire fabric or cold drawn steel wire is helically wound onto the pipe concurrently with the application of the cement-mortar coating near the center of the coating.



NWP0032924

Cross section of Beall cement mortar lined and coated pipe showing compacted texture of lining and mortar bond with the metal.

RECOMMENDED CEMENT MORTAR LINING AND COATING THICKNESSES FOR PIPE OF VARYING DIAMETERS, GAUGES AND WORKING PRESSURES.

Nominal inside diameter of pipe (inches)	Lining thickness (inches)	Coating thickness (inches, minimum)	*Nominal steel cylinder thickness—inches						
			Class 100	Class 150	Class 200	Class 250	Class 300	Class 350	Class 400
4	5/16	1/2	.0747	.0747	.0747	.0747	.0747	.0747	.0747
6	5/16	1/2	.0747	.0747	.0747	.0747	.0747	.1046	.1046
8	5/16	1/2	.0747	.0747	.0747	.0747	.1046	.1046	.1345
10	5/16	1/2	.0747	.0747	.0747	.1046	.1345	.1345	.1875
12	5/16	1/2	.0747	.0747	.1046	.1345	.1345	.1875	.1875
14	3/8	5/8	.0747	.1046	.1046	.1345	.1875	.1875	.2500
16	3/8	5/8	.0747	.1046	.1345	.1875	.1875	.2500	.2500
18	3/8	5/8	.0747	.1046	.1345	.1875	.2500	.2500	.3125
20	1/2	3/4	.0747	.1345	.1875	.1875	.2500	.3125	.3125
21	1/2	3/4	.0747	.1345	.1875	.1875	.2500	.3125	.3125
22	1/2	3/4	.1046	.1345	.1875	.2500	.2500	.3125	.3750
24	1/2	3/4	.1046	.1345	.1875	.2500	.3125	.3125	.3750
26	1/2	3/4	.1046	.1875	.1875	.2500	.3125	.3750	.3750
27	1/2	3/4	.1046	.1875	.2500	.2500	.3125	.3750	.4375
28	1/2	3/4	.1046	.1875	.2500	.2500	.3125	.3750	.4375
30	1/2	3/4	.1046	.1875	.2500	.3125	.3750	.3750	.4375
32	1/2	3/4	.1345	.1875	.2500	.3125	.3750	.4375	.5000
33	1/2	3/4	.1345	.1875	.2500	.3125	.3750	.4375	.5000
34	1/2	3/4	.1345	.1875	.2500	.3125	.3750	.4375	.5000
36	1/2	3/4	.1345	.1875	.2500	.3750	.4375	.5000	.5625
38	1/2	3/4	.1345	.2500	.3125	.3750	.4375	.5000	.5625
39	1/2	3/4	.1875	.2500	.3125	.3750	.4375	.5000	.5625
40	1/2	3/4	.1875	.2500	.3125	.3750	.4375	.5000	.6250
42	1/2	3/4	.1875	.2500	.3125	.3750	.5000	.5625	.6250

*The minimum thickness of steel cylinders shall not be less than No. 14 gauge (0.0747 inch).

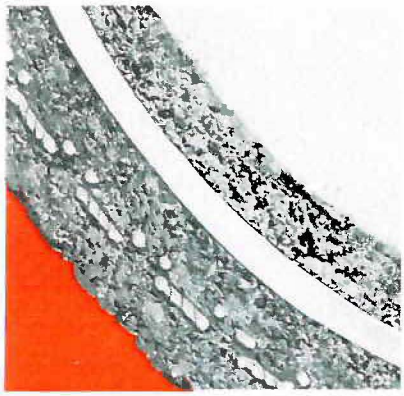


Photo of inside surface finish of Beall cement mortar lined pipe. This smooth, dense surface reduces flow resistance to minimum.

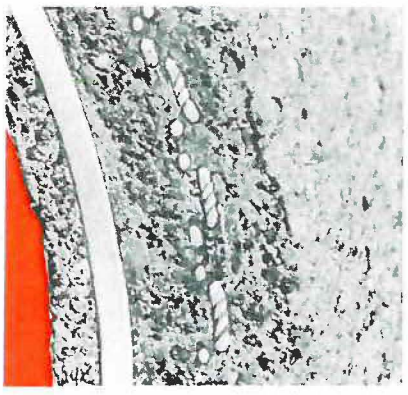
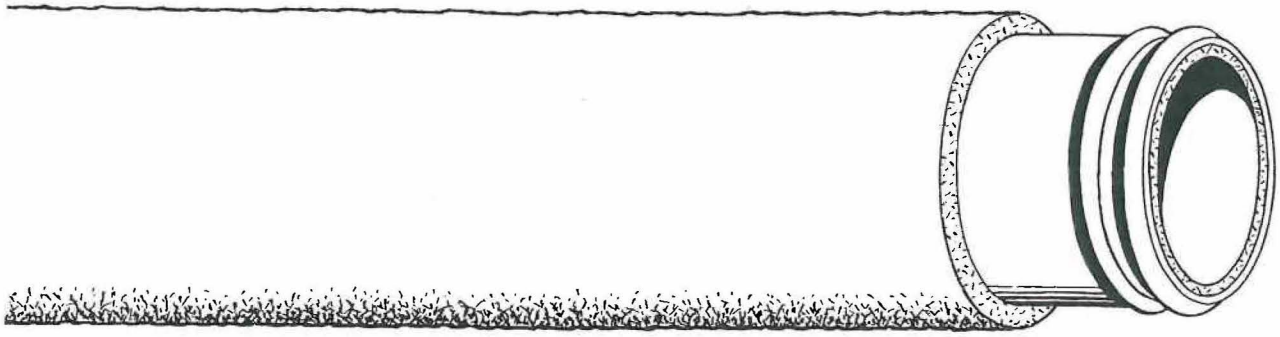
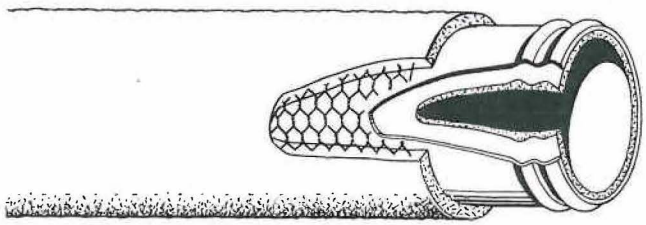


Photo of exterior surface finish of Beall mortar coated pipe. High pressure spray coating produces compact coating free from excessive voids.

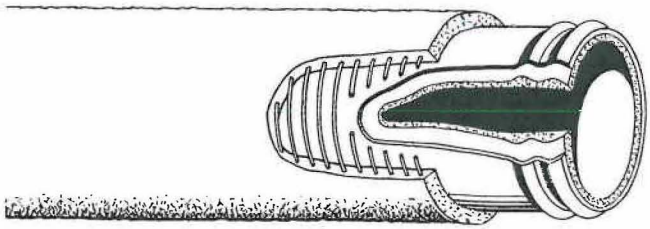
PIPE IS AVAILABLE IN A VARIETY OF CEMENT MORTAR LINING AND COATING COMBINATIONS





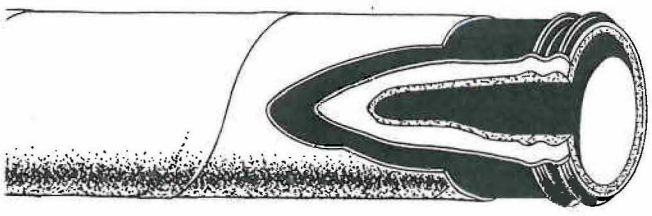
CEMENT MORTAR LINED AND WIRE MESH REINFORCED CEMENT MORTAR COATED PIPE

Wire mesh imbedded in the exterior coating gives the coating added strength to resist damage from uneven bedding and handling abuses.



CEMENT MORTAR LINED AND SPIRALLY WOUND WIRE REINFORCED MORTAR COATED PIPE

Further strengthening of the exterior coating is provided by the use of pre-stressed wire wrapping imbedded between successive applications of mortar.

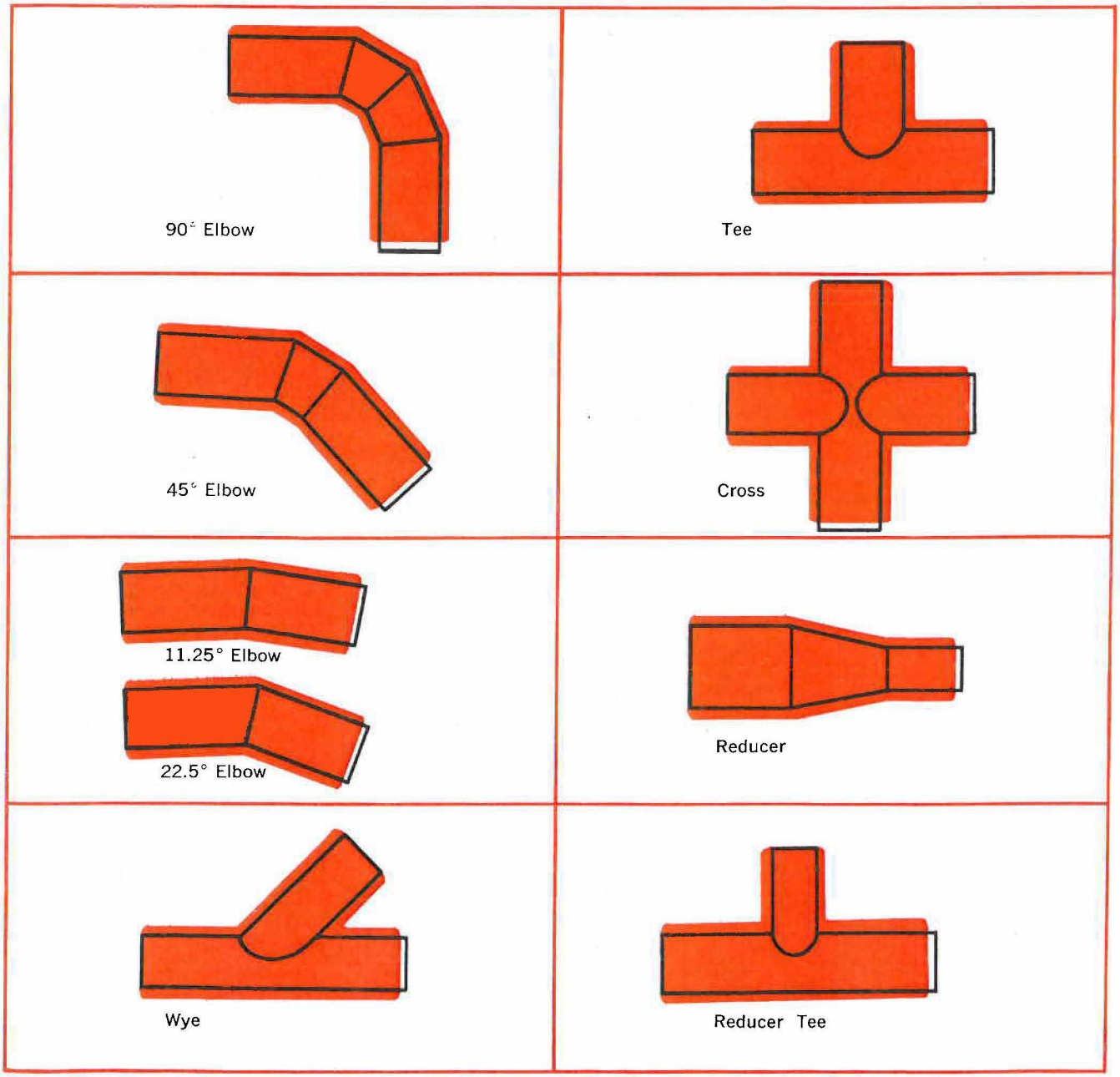


CEMENT MORTAR LINED AND COAL TAR OR PIONEER MINERAL RUBBER ASPHALT COATED AND WRAPPED PIPE

Soil conditions and installation facilities may be such that cement mortar lining can be used in combination with either coal tar enamel or Pioneer Mineral Rubber Asphalt coating. Either of these combinations offer an economical long life protection to the matchless qualities of welded steel pipe.

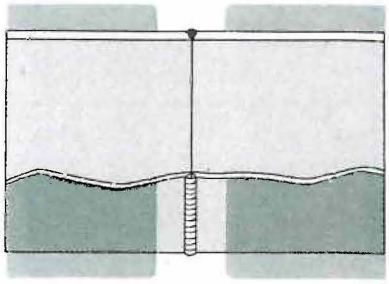
CEMENT MORTAR LINED AND COATED PIPE FITTINGS

Fabricated to match your engineered pipeline or special installation requirement. All of the standard tees, wyes, crosses, reducers, etc., as well as "special" fittings can be furnished in any combination of lining and coatings with end finishes to your specifications.

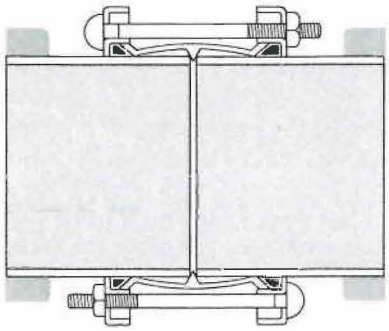


END FINISHES FOR CEMENT MORTAR LINED AND COATED PIPE

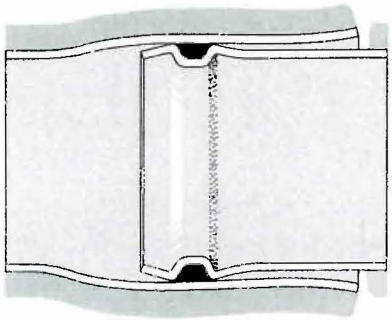
End finishes for cement mortar lined and coated pipe are usually fabricated for either rubber compression ring ("O" Ring) or bolted flange construction. However, end finishes for welding or any patented coupler system can be provided to specifications.



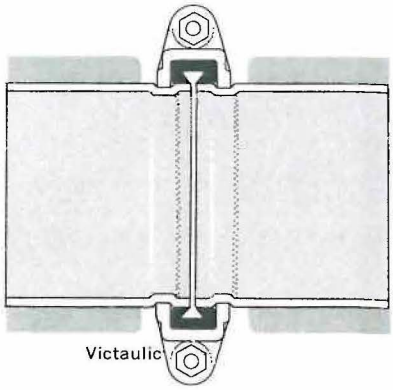
Weld End, Beveled



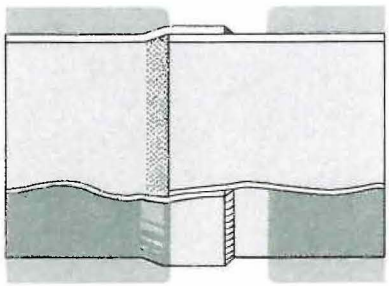
Dresser, Bolted



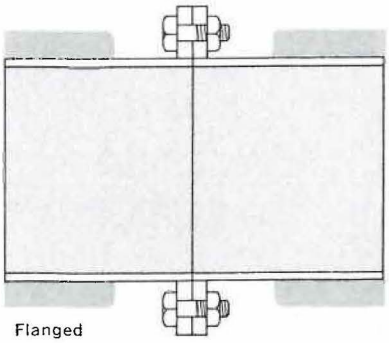
Bell and Spigot, for "O" Ring Gasket



Victaulic



Bell and Spigot, Slip Joint



Flanged

PIPE & TANK CORP.

PORTLAND OFFICE
12005 N. Burgard, Portland 3, Oregon
Phone AVenue 6-3631

PLANTS ALSO AT:

218 N. 16th St., Billings, Mont., Phone 252-7163
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5701 Colorado Blvd., Denver, Colo., Phone AT 8-0739
7001 San Leandro St., Oakland, Calif., Phone 569-0903

SALES OFFICES ALSO AT: Seattle • Spokane • Eugene • Klamath Falls

NWP0032928

PIPE FOR IRRIGATION

WELDED STEEL
PLAIN, GALVANIZED
OR COATED

Whether used for above or underground installation, Beall pipe makes a lasting, low-cost installation for mainlines and laterals. Beall irrigation pipe is available in the following types: High frequency resistance welded mild steel, bare or coated; High frequency resistance welded 16, 14, 12, or 10 gauge cold rolled galvanized steel, with hot zinc coating over the weld. (See chart on following page for sizes, gauges, etc.)

Protective coatings can further increase the service life of the pipe. End finishes to take most standard and quick-acting couplings can be furnished. All standard fittings including a full range of reducer tees are available.

NWP0032929

WELDED STEEL IRRIGATION PIPE

PLAIN • GALVANIZED • COATED

O.D. (Inches)	Wall Thickness Gauge or Fraction	WEIGHT—LB./FT. (Bare)	WEIGHT—LB./FT. Dipped	WEIGHT—LB./FT. Dipped and Wrapped	Head	Working Pressure (12,500 P.S.I.)
2	16	1.3	1.6	1.7	1725	747
2	14	1.5	1.8	1.9	2154	933
2	12	2.1	2.4	2.5	3018	1307
2	10	2.7	3.0	3.1	3882	1681
2-3/8	16	1.7	2.0	2.1	1450	628
2-3/8	14	1.9	2.2	2.3	1810	784
2-3/8	12	2.7	3.0	3.1	2536	1098
2-3/8	10	3.4	3.7	3.8	3264	1413
3	16	2.0	2.4	2.6	1150	498
3	14	2.5	2.9	3.1	1436	622
3	12	3.4	3.8	4.0	2011	871
3	10	4.4	4.8	5.0	2588	1121
3-1/2	16	2.3	2.8	3.0	986	427
3-1/2	14	2.9	3.4	3.6	1230	533
3-1/2	12	4.0	4.5	4.7	1725	747
3-1/2	10	5.1	5.6	5.8	2284	989
4	16	2.7	3.3	3.5	870	375
4	14	3.2	3.8	4.0	1175	510
4	12	4.5	5.1	5.3	1500	650
4	10	5.7	6.3	6.5	1935	840
4-1/2	14	3.6	4.3	4.5	965	420
4-1/2	12	5.0	5.7	5.9	1345	565
4-1/2	10	6.4	7.1	7.3	1720	745
4-1/2	3/16″	8.7	9.4	9.6	2420	1025
5	14	4.2	5.0	5.3	870	375
5	12	5.7	6.5	6.8	1210	525
5	10	7.3	8.1	8.4	1550	670
5	3/16″	10.1	10.9	11.2	2175	940
6	14	4.9	5.8	6.1	735	315
6	12	6.7	7.6	7.9	1030	445
6	10	8.6	9.6	9.9	1325	575
6	3/16″	12.1	12.8	13.1	1775	770
6-5/8	14	5.4	6.4	6.8	655	285
6-5/8	12	7.5	8.5	8.9	920	400
6-5/8	10	9.6	10.7	11.1	1165	505
6-5/8	3/16″	13.0	14.1	14.5	1640	710
8	14	6.5	7.5	8.0	550	235
8	12	9.0	10.3	10.8	775	335
8	10	11.6	12.8	13.3	1000	430
8	3/16″	16.1	17.3	18.0	1350	585
8-5/8	12	9.8	11.2	11.7	705	310
8-5/8	10	12.5	13.8	14.3	900	390
8-5/8	3/16″	17.4	18.7	19.2	1260	545
8-5/8	1/4″	22.4	23.7	24.2	1680	725
10	12	11.3	12.9	13.5	620	265
10	10	14.5	16.1	16.7	795	345
10	3/16″	20.2	21.8	22.4	1080	465
10	1/4″	26.0	27.5	28.1	1440	625
10-3/4	12	12.2	13.9	14.6	565	245
10-3/4	10	15.6	17.3	18.0	715	310
10-3/4	3/16″	21.7	23.4	24.1	1000	435
10-3/4	1/4″	28.0	29.6	30.3	1335	580
12	12	13.6	15.5	16.2	515	220
12	10	17.5	19.4	20.1	660	285
12	3/16″	24.3	25.2	25.9	900	390
12	1/4″	31.4	33.3	34.0	1200	520
12-3/4	12	14.5	16.5	17.2	480	210
12-3/4	10	18.6	20.6	21.3	610	265
12-3/4	3/16″	25.9	27.9	28.6	855	370
12-3/4	1/4″	33.4	35.4	36.1	1135	490
12-3/4	5/16″	41.5	43.5	44.2	1415	615
14	12	15.9	18.1	18.9	440	190
14	10	20.4	22.6	23.5	565	245
14	3/16″	28.4	30.7	31.5	775	335
14	1/4″	36.7	38.9	39.7	1030	445
14	5/16″	45.7	47.9	48.7	1285	555
16	10	23.4	25.9	27.4	495	215
16	3/16″	32.6	35.1	36.6	675	290
16	1/4″	42.1	44.6	46.1	900	390
16	5/16″	52.4	54.9	57.4	1125	485
18	10	26.3	29.2	30.9	440	190
18	3/16″	36.7	39.5	41.2	600	260
18	1/4″	47.4	50.2	51.9	800	345
18	5/16″	59.0	61.8	65.3	1000	430
20	10	29.2	32.5	34.2	395	170
20	3/16″	40.8	44.1	45.8	540	235
20	1/4″	52.7	56.1	57.8	720	310
20	5/16″	65.7	69.1	73.0	900	390
22	10	32.2	35.9	37.8	360	155
22	3/16″	44.9	48.6	50.5	490	210
22	1/4″	58.1	61.8	63.7	655	285
22	5/16″	72.4	76.1	80.4	815	350
24	3/16″	49.0	53.0	55.1	450	195
24	1/4″	63.4	67.4	69.5	600	260
24	5/16″	79.1	83.1	87.8	750	325

NWP0032930

PROTECTIVE COATINGS FOR BEALL IRRIGATION PIPE

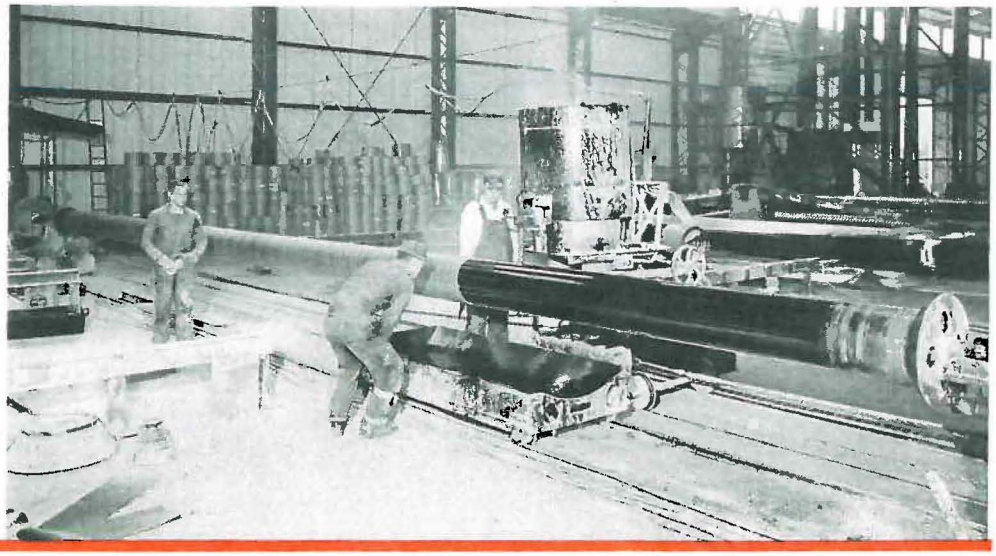
Beall welded steel irrigation pipe can be furnished either bare or coated. Protective coatings may be of hot coal tar enamel or Pioneer Mineral Rubber asphalt. Also, any combination of coating and asbestos felt wrapping is available.

ABOVE

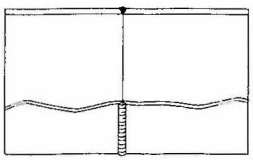
Beall pipe being removed from vertical dipping vat of superheated Pioneer Mineral Rubber Asphalt.

AT RIGHT

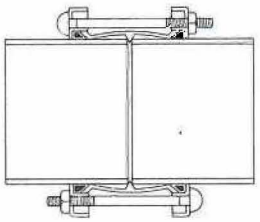
Asphalt saturated asbestos felt wrapping is bonded to pipe with hot Pioneer Mineral Rubber Asphalt.



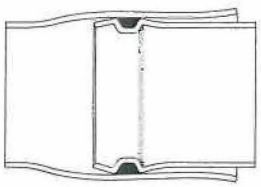
PIPE ENDS FINISHED FOR ALL CUSTOMARY AND PATENT COUPLER JOINING METHODS



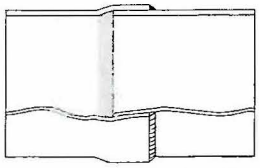
Weld End, Beveled



Dresser, Bolted



Bell and Spigot, for "O" Ring Gasket



Bell and Spigot, Slip Joint

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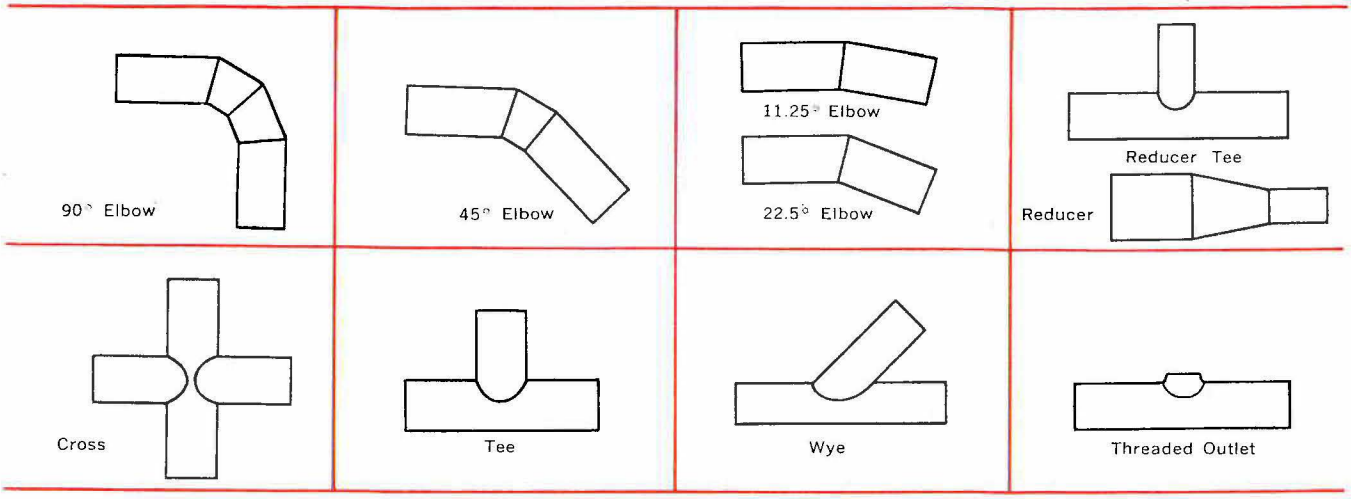
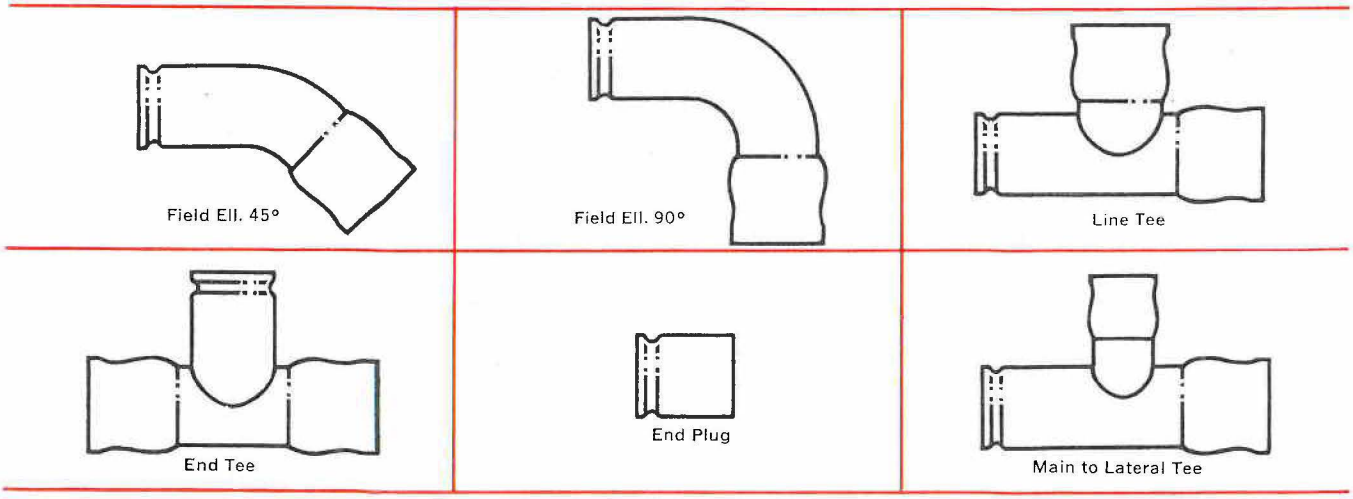
FABRICATED FITTINGS FOR BEALL IRRIGATION PIPE

Shop fabricated fittings in all the standard designs are made of the same material as the pipe. These fittings are also available coated or coated and wrapped to match the pipe specifications. Special fittings with lateral reducers are supplied on order.



GALVANIZED "O" RING FITTINGS FOR BEALL TYPE IRRIGATION PIPE



BEALL

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EXHIBIT S-24-1.3

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Specifications and
Design Details and
Dimensions for

COAL-TAR ENAMEL LINED & COATED STEEL PIPE 4" thru 96"

BEALL
PIPE & TANK CORPORATION
GENERAL OFFICES
12005 NORTH BURGARD
PORTLAND, OREGON 97203
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The material and tables found in this publication are issued for the purpose of establishing design criteria, design details and dimensions, and external load capabilities for Coal-Tar Enamel Lined & Coated Steel Pipe for use in the transmission and distribution of water.

For additional information concerning the material contained in this standard, please write to Beall Pipe & Tank Corporation, Welded Steel Pipe Division, 12005 North Burgard, Portland, Oregon 97203, or any of the sales offices listed on the back of this publication.

Issued by
BEALL PIPE & TANK CORPORATION
12005 North Burgard
Portland, Oregon 97203

NWP0032935

INDEX

NWP0032936

A. GENERAL

1. Scope

This specification is the Beall Pipe & Tank Corporation standard specification for the design, fabrication, lining and coating of coal-tar enamel lined and coated steel pipe, 4" thru 96", for use in the transmission and distribution of water.

2. Submittals

The Contractor shall provide joint details for each size and class and line layouts or line schedules which indicate the location of each section of pipe and each special fitting to be furnished. These details and drawings shall be submitted to the Engineer for approval prior to fabrication.

3. Manufacturer

The pipe shall be manufactured by a firm which has had at least ten years' successful experience in the manufacture of coal-tar enamel lined and coated steel pipe.

4. Components

The pipe shall consist of the following component parts: a welded steel, sheet or plate, cylinder with joints formed integrally with the steel cylinder; a coal-tar enamel lining and coating; a pipeline felt wrap over the coal-tar enamel coating; a self-centering bell and spigot joint with a circular reformed elastomeric gasket, so designed that the joint will be watertight under all conditions of service. Maximum laying length of pipe sections shall be as specified by the purchaser.

B. STEEL CYLINDERS

1. Material

Cylinders shall be fabricated from hot-rolled, carbon steel sheets or plates, conforming to the requirements of the latest revision of A.S.T.M. Designation A 570 Grade C, D or E, or A.S.T.M. Designation A 415, except that the carbon content may be 0.25%. Plates shall conform to the requirements of A.S.T.M. Designation A 283 Grade B or C.

2. Fabrication

Sheets or plates shall be fabricated into cylinders with either longitudinal or helical seams. All longitudinal or helical seams shall be butt welds and shall be made by an automatic process, either submerged arc or electric resistance, which produces welds with tensile strength equal to that of the sheet or plate.

3. Steel Area

Unless otherwise specified, the wall thickness of the steel cylinder shall be computed on the basis of having a minimum stress of 16,500 PSI in the steel at the design pressure, but shall be not less than the thickness of No. 14 gage.

4. Testing

After each cylinder is completed, but prior to lining or coating, it shall be tested hydrostatically to a minimum circumferential tensile stress equal to 75 percent of its specified minimum yield strength. Cylinders which show any leakage under test shall be rewelded at the points of leakage and subjected to another hydrostatic test. The finished steel cylinder shall be completely watertight under the required test pressure.

C. JOINTS

1. Fabrication

The joint shall be an O-Ring bell and spigot type, utilizing a rubber gasket to achieve a watertight seal. Bell and spigot ends shall be formed integrally with the steel cylinder by sizing with a machine swage or die, or by rolling with suitable rolling equipment.

Bell and spigot ends shall be circular in shape and shall be so designed that the gasket will be restrained or confined to an annular space in such a manner that movement of the pipe or hydrostatic pressure cannot displace the gasket. Compression of the gasket in joint-closure position shall not be dependent upon water pressure in the pipe, and the compressed gasket shall substantially fill the annular space and effect a watertight seal. The gasket shall be of such size that when the outer surface of the spigot and the inner surface of the bell come into contact at some portion of their peripheries, the deformation in the gasket shall not exceed 50 percent at the point of contact and at the diametrically opposite point shall not be less than 15 percent of the stretched gasket diameter. The gasket shall be the sole element of the joint dependent upon to provide watertightness. The difference in circumferential measurement between the outside circumference of the spigot and the inside circumference of the bell shall be 0.060 inch minimum and 0.200 inch maximum as measured at the edge of a compressed gasket at nominal joint-closure position. The unlined interior surface of the bell and the uncoated exterior surface of the spigot shall be protected by a corrosion-resistant paint.

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2. Rubber Gaskets

The gasket sealing the joint shall be a continuous ring made of a special composition rubber not subject to biologic degradation. The length of the gasket shall be volumetrically determined so that it will fill the joint recess provided.

The rubber compound shall contain no factice, reclaimed rubber or any deleterious substance. All rubber gaskets shall be extruded or molded and cured in such a manner that any cross-section will be dense, homogenous, and free from porosity, blisters, pitting and other imperfections. The gaskets shall be extruded or molded with smooth surfaces to the specified diameter.

The rubber compound shall meet the following physical requirements when tested in accordance with the applicable sections of Federal Test Method Standard No. 601 and appropriate ASTM Methods of Test as indicated:

(a) Natural Rubber (by volume) min. %	65
(b) Tensile Strength, PSI, min. ASTM D 412	3,000
(c) Elongation at rupture, percentage, min. ASTM D 412	500
(d) Shore Surometer, Type A (center o preferred) ASTM D 676 (the test shall be performed on the flat cross-section of a ½" length of gasket).	55-+5
(e) Compression Set, percentage or original deflection, max. Method B (½" long section of gasket, constant deflection, 22 hours at 158°F.) ASTM D 395.	20
(f) Accelerated aging in air (96 hours at 158°F.) ASTM D 573. Tensile strength, percentage of orig. strength, min.	80
(g) Water absorption by weight, percentage, max. (24 hours at 158°F.)	1.5
(h) Acetone extract, percentage, max. ASTM D 297	15
(i) Specific gravity, ASTM D 297	1.10 to 1.20

All gaskets shall be stored in a cool, well-ventilated place. During shipment and storage, the gaskets shall also be protected from the direct rays of the sun.

D. COAL-TAR ENAMEL COATING

1. Materials

a. **Coal-Tar Primer:** The primer shall consist of processed coal-tar pitch and refined coal-tar oils only, blended to produce a liquid coating which may be applied cold by brushing or spraying and which will produce an effective bond between the metal and subsequent coating of coal-tar enamel. Primer shall contain no benzol or other toxic, or highly volatile solvents and no added pigments or inert fillers.

b. **Coal-Tar Enamel:** The enamel used for the exterior coating shall be composed of a specially processed coal-tar pitch combined with an inert mineral filler. No asphalt of either petroleum or natural base shall be included as part of the enamel used. The enamel shall conform to the requirements of the AWWA Standard C-203-66 Section 2.2 Table I which are as follows:

CHARACTERISTICS OF AWWA COAL-TAR ENAMEL

TEST	Minimum	Maximum
Softening point—ASTM D36-64T	220°F	. . .
Filler (ash)—ASTM D271-64	25%	35%
Fineness filler, through 200 mesh—ASTM D546-55	90%	. . .
Specific gravity at 25°C—ASTM D71-52	1.40	1.60
*Penetration—ASTM D5-65		
At 77°F—100-g weight—5 sec.	10	20
At 115°F—50-g weight—5 sec.	15	55
High-temperature test—at 160°F (sag)—AWWA C203, Sec. 2.4.4 (1)	. . .	2/32"
Low-temperature test—at -20°F (cracking)—AWWA C203, Sec. 2.4.4 (2)	. . .	None
†Deflection test (initial heating)—AWWA C203, Sec. 2.4.4 (3)		
Initial crack	0.8"	. . .
Disbonded area	. . .	3.0 sq.in.
†Deflection test (after heating)—AWWA C203, Sec. 2.4.4 (4)		
Initial crack	0.6"	. . .
Disbonded area	. . .	5.0 sq.in.
†Impact test—at 77°F—650-g ball, 8-ft. drop—AWWA C203, Sec. 2.4.4 (6)		
Direct impact—disbonded area	. . .	10.0 sq.in.
Indirect impact—disbonded area	. . .	2.0 sq.in.
Peel test—AWWA C203, Sec. 2.4.4. (5)	no peeling	

*For anticipated minimum temperature exposures between 20°F and -20°F, use penetration of 15 to 20 at 77°F.

†Choice of bond testing methods A or B by deflection (before heating), by deflection (after heating), or by impact shall depend upon laboratory equipment available.

2. Priming

After completion of the fabrication and testing operations, all surfaces of the pipe cylinder shall be thoroughly cleaned by blasting, and all foreign matter not removable by blasting shall be removed by other suitable means. All blasted steel surfaces shall be dry and cleaned of dust and grit and shall be primed immediately following blasting and cleaning. The primer shall be applied by hand brushing, air gun spraying or spraying-and-brushing in accordance with instructions for application as supplied by the manufacturer of the primer.

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After application, the coal-tar priming coat shall be uniform, free from floods, runs, sags, drips, holidays or bare spots. Any bare spots or holidays shall be recoated with an additional application of primer. All runs, sags, floods or drips shall be removed by scraping and cleaning and the clean area repaired.

3. Lining Application

The coal-tar enamel lining shall be applied by centrifugally casting the coal-tar enamel utilizing a retracting feed line. The feed line shall be inserted into the pipe to be coated until the nozzle has reached the far end of the length of pipe. Then the pipe shall be spun, utilizing rubber-tired wheels, at a predetermined speed depending upon the diameter of the pipe to be lined.

During the spinning operation, the molten coal-tar enamel feed line shall be energized and retracted from the pipe at a rate of travel properly coordinated with the speed of pipe rotation to insure a uniform 3/32" application of the enamel lining. Supply of enamel to the feed line nozzle from the reservoir shall be by means of a power-driven circulation pump.

4. Coating Application

The coal-tar coating shall be applied by rotating the pipe and pouring the enamel on the revolving pipe as it passes thru the coating machine at a set rate of travel. Rate of travel, to provide the specified 3/32 of an inch thickness, shall be determined by the diameter of the pipe to be coated. Enamel shall be applied so that each spiral resulting from the spreading operations shall overlap the preceding spiral, producing a continuous coat free from defects or holidays.

5. Tolerances

The following lining and coating tolerances shall apply to completed pipe:

(a) The completed lining thickness shall be 3/32 of an inch and the allowable variation in thickness shall not exceed plus or minus 1/32 of an inch.

(b) The completed coating thickness shall be 3/32 of an inch and the allowable variation in thickness shall not exceed plus or minus 1/32 of an inch.

E. WRAPPING
1. Materials

a. **Asbestos Coal-Tar Saturated Felt:** The wrapper shall be composed of an asbestos felt having an asbestos content of not less than 85 percent of the desaturated felt with suitable binder and a weight of not less than 12 pounds, nor more than 15 pounds per 100 square feet.

b. **Kraft Paper:** The kraft paper shall be an 80 pound, 100 percent sulphate, smooth paper.

2. Wrapping Application

During the coal-tar enamel coating stage of the operation, the pipe shall be wrapped with a pipe line felt as specified in section E 1.a of these specifications. The asbestos coal-tar saturated felt shall be spirally applied by means of a continuous endfeed machine under sufficient tension to be free of wrinkles and buckles and to definitely bond the felt to the exterior coating of the pipe. The lap of the felt on succeeding spirals shall not be less than ½ inch.

Over the bonded asbestos felt wrapper shall be applied a spiral wrapping of kraft paper as specified in section E 1.b of these specifications.

Double wrapping with asbestos felt, the use of a fiberglass mat wrap or combinations of felt, fiberglass and kraft paper as specified by the Purchaser are possible alternates.

F. BENDS & SPECIALS
1. Joint Deflection

Laying of pipe to curved alignment may be accomplished by deflecting the individual pipe sections at the joints in accordance with Table A below.

TABLE A

Nominal Pipe Diameter	Allowable Joint Deflection[1]	Nominal Pipe Diameter	Allowable Joint Deflection[1]
4″	5° 00′	26″	2° 10′
6″	5° 00′	27″	2° 06′
8″	5° 00′	28″	2° 00′
10″	4° 08′	30″	1° 54′
12″	3° 28′	32″	1° 46′
14″	3° 00′	33″	1° 44′
16″	2° 38′	34″	1° 40′
18″	2° 20′	36″	1° 34′
20″	2° 06′	38″	1° 30′
21″	2° 00′	39″	1° 28′
22″	1° 56′	40″	1° 26′
24″	1° 46′	42″	1° 22′
		48″	1° 10′

[1]The angular deflection at bell and spigot joints shall in no case exceed 5 degrees. Allowable joint deflections for pipe sizes not shown are available upon request. For the purpose of reducing the angular deflection to joints, and for closure sections, pipe sections of shorter than standard 40 foot lengths should be used.

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2. Bends

Where curves are required which have a shorter radius than can be obtained by deflecting pipe at the joints, beveled ends can be furnished for deflection to 5 degrees in most diameters. Where indicated on the drawings, short radius bends shall be fabricated from steel cylinders. Bends shall be equal in strength to the abutting pipe sections. After fabrication, the bends shall be coal-tar enamel lined and coated and wrapped in accordance with Sections D2., D3., D4., and E2. of these specifications. The design of such bends shall be approved by the Engineer prior to fabrication.

3. Special Fittings

Special fittings such as wyes, tees, crosses and etc., shall be constructed of steel cylinders and shall be coal-tar enamel lined and coated and wrapped after fabrication. Fittings shall be equal in strength to the abutting pipe sections. The design of such fittings shall be approved by the Engineer prior to fabrication.

4. Outlets

Outlets shall be built into the wall of the pipe for blow-offs, branches, air valves and access manholes. They shall be made of cast or fabricated steel of suitable design and securely welded to the cylinder before being coal-tar enamel lined and coated and wrapped. The cylinder shall be reinforced, as necessary, for the opening. The design of such outlets shall be approved by the Engineer prior to fabrication.

5. Tension Joints

Pipe ends shall be prepared for tension joints as shown on the plans and as designated by the Engineer. The tension joint, will be designed by the Engineer, with a cylinder and welds of sufficient strength to withstand the longitudinal forces due to closed valves, reducers, curved alignment and steep slopes. Shop drawings, showing the design of tension sections and design calculations of the forces the pipe will safely withstand, shall be submitted to the Engineer for approval prior to manufacture of these sections.

6. Testing

Completed special fittings, short joint, utilizing cylinders previously tested as described under Section B-4, shall not require additional testing.

G. MARKING HANDLING & SHIPPING

1. Marking

Each length of pipe shall be marked with paint on the spigot end with numbers corresponding to the shop drawings to indicate its position in the line. The marking shall be on the inside and/or outside of the pipe with legible lettering. All beveled pipe shall be marked with the amount of bevel. On specials such as bevels, reducers, tees and bends, the top shop center line and top field center line shall be marked on the ends of the pipe.

Coal-tar enamel lined and coated pipe shall be marked with the class of pipe, and each pipe shall have a shop number marked so that it may easily be identified in the storage yard.

2. Bracing

Internal bracing shall be placed at the ends of the pipe and elsewhere, if necessary, to prevent the pipe from exceeding 0.5 percent out-of-roundness measured on the pipe diameter, and all such bracing required to maintain roundness shall remain in place until the pipe has been delivered to the trench site.

3. Handling

The pipe shall not be dropped or subjected to any unnecessary jar, impact or other treatment that might injure the coal-tar enamel lining or coating or otherwise damage the pipe. Any unit of pipe that in the opinion of the Engineer is damaged beyond repair by the Contractor shall be replaced by another unit reinforced for the same or greater head. Any pipe that is damaged and repairable shall be repaired in the field, or at the direction of the Engineer, returned to the manufacturing plant for repair.

STANDARD DESIGN TABLES

TABLE 1

PIPE O.D.[1] (inches)	WALL THICKNESS [2 3]		PIPE I.D. (inches)	WEIGHT (Bare) lb./ft.	ALLOWABLE WORKING PRESSURE—PSI WITH S=50% OF YIELD POINT[4]		
	Gage or Fraction	Decimal (inches)			S=16,500	S=21,000	S=26,000
3″	14	0.075	2.85	2.3	825	1050	1300
	12	0.105	2.79	3.3	1155	1470	1820
	10	0.135	2.73	4.1	1485	1890	2340
3½″	14	0.075	3.35	3.1	707	900	1114
	12	0.105	3.29	4.4	990	1260	1561
	10	0.135	3.23	5.6	1270	1620	2040
4″	14	0.075	3.85	3.1	619	787	975
	12	0.105	3.79	4.4	865	1100	1365
	10	0.135	3.73	5.6	1112	1420	1755
	3/16″	0.188	3.63	7.6	1550	1975	2440
4½″	14	0.075	4.35	3.5	550	700	866
	12	0.105	4.29	4.9	770	979	1215
	10	0.135	4.23	6.3	990	1260	1560
	3/16″	0.188	4.13	8.6	1375	1755	2175
5″	14	0.075	4.85	3.9	495	630	780
	12	0.105	4.79	5.5	694	882	1091
	10	0.135	4.73	7.0	891	1134	1404
	3/16″	0.188	4.63	9.6	1240	1580	1956
6″	14	0.075	5.85	4.7	412	525	650
	12	0.105	5.79	6.6	578	735	911
	10	0.135	5.73	8.4	742	945	1170
	3/16″	0.188	5.63	11.6	1032	1317	1630
6⅝″	14	.075	6.47	5.2	374	475	589
	12	.105	6.41	7.3	523	665	825
	10	.135	6.35	9.3	672	856	1060
	3/16″	.188	6.25	12.9	935	1193	1477
	1/4″	.250	6.12	17.0	1246	1585	1962
8″	14	.075	7.85	6.3	309	394	488
	12	.105	7.79	8.8	433	551	683
	10	.135	7.73	11.3	556	710	877
	3/16″	.188	7.63	15.7	775	988	1223
	1/4″	.250	7.50	20.7	1031	1310	1625
8⅝″	14	.075	8.47	6.8	287	365	452
	12	.105	8.41	9.5	401	511	634
	10	.135	8.35	12.2	516	657	814
	3/16″	.188	8.25	16.9	718	915	1134
	1/4″	.250	8.12	22.4	956	1220	1509
10″	12	.105	9.79	7.9	346	441	546
	10	.135	9.73	11.1	445	567	702
	3/16″	.188	9.63	14.2	620	789	977
	1/4″	.250	9.50	19.7	825	1050	1300
10¾″	12	.105	10.54	11.9	322	410	509
	10	.135	10.48	15.3	415	528	653
	3/16″	.188	10.37	21.2	576	735	910
	1/4″	.250	10.25	28.0	767	976	1210
12″	12	.105	11.79	13.3	289	367	455
	10	.135	11.73	17.1	371	472	585
	3/16″	.188	11.63	23.7	516	658	815
	1/4″	.250	11.50	31.4	688	875	1083
12¾″	12	.105	12.54	14.1	272	346	429
	10	.135	12.48	18.1	350	445	550
	3/16″	.188	12.37	25.2	486	620	766
	1/4″	.250	12.25	33.4	647	824	1020
14″	12	.105	13.79	15.5	247	315	390
	10	.135	13.73	19.9	318	405	501
	3/16″	.188	13.63	27.7	443	565	698
	1/4″	.250	13.50	36.7	590	750	928
16″	12	.105	15.79	17.8	216	276	341
	10	.135	15.73	22.8	278	354	439
	3/16″	.188	15.63	31.7	388	494	611
	1/4″	.250	15.50	42.1	516	656	813
18″	12	.105	17.79	20.0	192	245	303
	10	.135	17.73	25.7	248	315	390
	3/16″	.188	17.63	35.7	344	439	543
	1/4″	.250	17.50	47.4	458	584	722
20″	12	.105	19.79	22.2	173	220	273
	10	.135	19.73	28.5	223	284	351
	3/16″	.188	19.63	39.7	310	395	489
	1/4″	.250	19.50	52.7	412	525	650

PIPE O.D.[1] (inches)	WALL THICKNESS[2,3] Gage or Fraction	WALL THICKNESS[2,3] Decimal (inches)	PIPE I.D. (inches)	WEIGHT (Bare) lb./ft.	ALLOWABLE WORKING PRESSURE—PSI WITH S=50% OF YIELD POINT[4] S=16,500	S=21,000	S=26,000
22″	12	.105	21.79	24.5	157	200	248
	10	.135	21.73	31.4	203	258	319
	3/16″	.188	21.63	43.7	282	359	444
	1/4″	.250	21.50	58.1	375	477	591
24″	12	.105	23.79	26.7	144	184	227
	10	.135	23.73	34.3	186	236	292
	3/16″	.188	23.63	47.7	258	329	407
	1/4″	.250	23.50	63.4	344	438	541
	5/16″	.313	23.37	79.1	431	548	678
26″	10	.135	25.73	37.2	171	218	270
	3/16″	.188	25.63	51.7	238	304	376
	1/4″	.250	25.50	68.8	317	404	500
	5/16″	.313	25.37	85.7	398	505	625
	3/8″	.375	25.25	102	475	606	750
	7/16″	.438	25.12	119	555	708	875
	1/2″	.500	25.00	136	635	807	1000
28″	10	.135	27.73	40.0	159	202	250
	3/16″	.188	27.63	55.7	221	282	349
	1/4″	.250	27.50	74.1	294	375	464
	5/16″	.313	27.37	92.4	369	470	581
	3/8″	.375	27.25	111	441	563	697
	7/16″	.438	27.12	129	516	657	813
	1/2″	.500	27.00	147	590	750	928
30″	10	.135	29.73	42.9	148	189	234
	3/16″	.188	29.63	59.7	206	263	325
	1/4″	.250	29.50	79.4	275	350	433
	5/16″	.313	29.37	99.1	344	439	542
	3/8″	.375	29.25	119	412	525	650
	7/16″	.438	29.12	138	481	614	758
	1/2″	.500	29.00	158	550	700	867
32″	10	.135	31.73	45.8	139	177	219
	3/16″	.188	31.63	63.7	193	247	305
	1/4″	.250	31.50	84.8	258	328	406
	5/16″	.313	31.37	105	323	411	508
	3/8″	.375	31.25	126	386	492	610
	7/16″	.438	31.12	147	451	575	711
	1/2″	.500	31.00	168	515	655	812
34″	10	.135	33.73	48.7	131	166	206
	3/16″	.188	33.63	67.7	182	232	287
	1/4″	.250	33.50	90.1	242	309	382
	5/16″	.313	33.37	112	304	387	479
	3/8″	.375	33.25	135	363	463	574
	7/16″	.438	33.12	157	425	541	669
	1/2″	.500	33.00	179	485	618	765
36″	10	.135	35.73	51.5	124	157	195
	3/16″	.188	35.63	71.7	172	219	271
	1/4″	.250	35.50	95.5	229	292	361
	5/16″	.313	35.37	119	287	365	452
	3/8″	.375	35.25	143	343	437	542
	7/16″	.438	35.12	166	401	511	632
	1/2″	.500	35.00	190	458	583	722
40″	3/16″	.188	39.63	79.7	155	197	244
	1/4″	.250	39.50	106	206	262	325
	5/16″	.313	39.37	132	258	329	406
	3/8″	.375	39.25	159	309	393	488
	7/16″	.438	39.12	185	361	460	569
	1/2″	.500	39.00	211	412	525	650
42″	3/16″	.188	41.63	83.7	147	188	232
	1/4″	.250	41.50	111	196	250	309
	5/16″	.313	41.37	139	246	313	387
	3/8″	.375	41.25	167	294	375	464
	7/16″	.438	41.12	194	344	438	541
	1/2″	.500	41.00	222	393	500	619
48″	3/16″	.188	47.63	95.8	129	164	203
	1/4″	.250	47.50	128	172	219	271
	5/16″	.313	47.37	159	215	274	339
	3/8″	.375	47.25	191	257	328	407
	7/16″	.438	47.12	222	301	383	474
	1/2″	.500	47.00	254	343	438	541
54″	3/16″	.188	53.63	108	115	146	181
	1/4″	.250	53.50	144	152	194	241
	5/16″	.313	53.37	179	191	244	301
	3/8″	.375	53.25	215	229	291	361
	7/16″	.438	53.12	250	268	340	421
	1/2″	.500	53.00	286	305	389	481
60″	1/4″	.250	59.50	160	137	175	216
	5/16″	.313	59.37	199	172	219	271
	3/8″	.375	59.25	239	206	262	325
	7/16″	.438	59.12	278	241	306	379
	1/2″	.500	59.00	318	275	350	434

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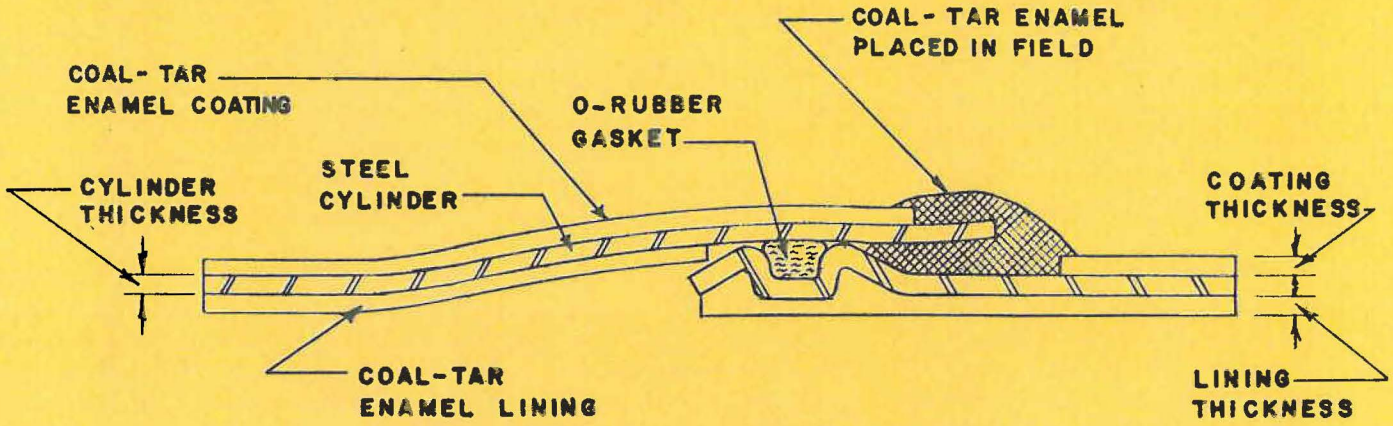
PIPE O.D.[1] (inches)	WALL THICKNESS [2 3] Gage or Fraction	WALL THICKNESS [2 3] Decimal (inches)	PIPE I.D. (inches)	WEIGHT (Bare) lb./ft.	ALLOWABLE WORKING PRESSURE—PSI WITH S=50% OF YIELD POINT[4] S=16,500	S=21,000	S=26,000
66"	1/4"	.250	65.50	176	125	159	197
	5/16"	.313	65.37	219	156	199	246
	3/8"	.375	65.25	263	187	238	295
	7/16"	.438	65.12	306	219	279	345
	1/2"	.500	65.00	350	250	318	394
72"	1/4"	.250	71.50	192	114	146	180
	5/16"	.313	71.37	239	143	182	226
	3/8"	.375	71.25	287	171	219	271
	7/16"	.438	71.12	334	201	255	316
	1/2"	.500	71.00	382	229	291	361
78"	1/4"	.250	77.50	208	105	134	166
	5/16"	.313	77.37	259	132	168	208
	3/8"	.375	77.25	311	158	202	250
	7/16"	.438	77.12	362	185	236	291
	1/2"	.500	77.00	414	211	269	333
84"	5/16"	.313	83.37	279	123	156	193
	3/8"	.375	83.25	335	147	187	232
	7/16"	.438	83.12	390	172	219	271
	1/2"	.500	83.00	446	196	250	309
90"	5/16"	.313	89.37	299	115	146	180
	3/8"	.375	89.25	359	137	175	216
	7/16"	.438	89.12	418	160	204	253
	1/2"	.500	89.00	478	183	233	289
96"	5/16"	.313	95.37	319	107	137	169
	3/8"	.375	95.25	383	128	164	203
	7/16"	.438	95.12	447	150	191	237
	1/2"	.500	95.00	510	172	218	271



YIELD POINT AND TENSILE STRENGTH COMPARISON
FOR A.S.T.M. A 283, A.S.T.M. A 570 AND A.P.I. 5LX

TABLE 2

STEEL SPECIFICATION	GRADE	YIELD POINT (MIN. PSI)	TENSILE STRENGTH (MIN. PSI)
A.S.T.M. A 283 (Plates)	A	24,000	45,000
	B	27,000	50,000
	C	30,000	55,000
	D	33,000	60,000
A.S.T.M. A 570 (Sheets & Coils)	A	25,000	45,000
	B	30,000	49,000
	C	33,000	52,000
	D	40,000	55,000
	E	42,000	58,000
A.P.I. 5LX (Sheets & Coils)	X42	42,000	60,000
	X46	46,000	63,000
	X52	52,000	66,000

NOTES:

[1]In the diameter range of 14" thru 96", cylinder outside diameters other than those shown are available upon request.

[2]Required wall thicknesses for diameters thru 96" O.D. and for pressure classes not shown are available upon request.

[3]Required wall thicknesses for welded steel pipe shown in the accompanying tables are based on the formula:

$$t = \frac{(P)(D)}{2S}$$ (Minimum t shall not be less than 14 ga.)

where: t = Required cylinder thickness, in inches
P = Internal working pressure of pipe, in psi
D = Outside diameter of cylinder, in inches
S = Allowable steel design stress, in psi
S is determined by the yield point of the grade of steel being used utilizing a safety factor of 2.

$$S \text{ allowable} = \frac{\text{Yield Point}}{2}$$

[4]High yield point steels are readily available and should be considered in preparing practical and economical pipeline designs, especially in the instances of large diameters, or high internal pressures, or both. Information on steels available is shown in Table 2.

ALLOWABLE TRENCH BACKFILL LOADING

TABLE 3

NOMINAL DIAMETER (inches)	WALL THICKNESS (inches)	85% COMPACTION Allowable Pv (psf)	85% COMPACTION Allowable h (feet)	70% COMPACTION Allowable Pv (psf)	70% COMPACTION Allowable h (feet)
12	.0747	2057	18.7	803	7.3
	.1046	2156	19.6	1012	9.2
	.1345	2420	22.0	1474	13.4
	.1875		*		**
14	.0747	2013	18.3	759	6.9
	.1046	2090	19.0	858	7.8
	.1345	2244	20.4	1122	10.2
	.1875	2937	26.7	2145	19.5
	.2500		*		**
16	.0747	2013	18.3	671	6.1
	.1046	2057	18.7	814	7.4
	.1345	2156	19.6	968	8.8
	.1875	2530	23.0	1562	14.2
	.2500		*		**
18	.0747	1980	18.0	660	6.0
	.1046	2024	18.4	781	7.1
	.1345	2090	19.0	869	7.9
	.1875	2310	21.0	1276	11.6
	.2500	3080	28.0		**
20	.0747	1980	18.0	649	5.9
	.1046	2013	18.3	726	6.6
	.1345	2057	18.7	814	7.4
	.1875	2200	20.0	1100	10.0
	.2500	2717	24.7	1771	16.1
21	.0747	1980	18.0	638	5.8
	.1046	2013	18.3	704	6.4
	.1345	2057	18.7	803	7.3
	.1875	2167	19.7	1045	9.5
	.2500	2563	23.3	1650	15.0
22	.1046	2013	18.3	671	6.1
	.1345	2024	18.4	792	7.2
	.1875	2156	19.6	990	9.0
	.2500	2420	22.0	1474	13.4
24	.1046	1980	18.0	660	6.0
	.1345	2013	18.3	770	7.0
	.1875	2112	19.2	902	8.2
	.2500	2310	21.0	1276	11.6
26	.1046	1980	18.0	649	5.9
	.1345	2013	18.3	715	6.5
	.1875	2068	18.8	847	7.7
	.2500	2244	20.4	1111	10.1
28	.1046	1980	18.0	638	5.8
	.1345	2013	18.3	671	6.1
	.1875	2057	18.7	814	7.4
	.2500	2167	19.7	1045	9.5
30	.1046	1980	18.0	627	5.7
	.1345	1980	18.0	660	6.0
	.1875	2057	18.7	792	7.2
	.2500	2123	19.3	979	8.9
32	.1345	1980	18.0	649	5.9
	.1875	2024	18.4	781	7.1
	.2500	2112	19.2	891	8.1
33	.1345	1980	18.0	638	5.8
	.1875	2013	18.3	770	7.0
	.2500	2090	19.0	880	8.0
34	.1345	1980	18.0	627	5.7
	.1875	2013	18.3	748	6.8
	.2500	2090	19.0	858	7.8
36	.1345	1980	18.0	605	5.5
	.1875	2013	18.3	726	6.6
	.2500	2068	18.8	836	7.6
38	.1345	1980	18.0	583	5.3
	.1875	2013	18.3	693	6.3
	.2500	2057	18.7	814	7.4
39	.1875	2013	18.3	671	6.1
	.2500	2057	18.7	803	7.3
	.3125	2134	19.4	935	8.5
40	.1875	2013	18.3	660	6.0
	.2500	2057	18.7	792	7.2
	.3125	2123	19.3	913	8.3
42	.1875	1980	18.0	660	6.0
	.2500	2024	18.4	781	7.1
	.3125	2090	19.0	869	7.9
48	.1875	1980	18.0	649	5.9
	.2500	2013	18.3	726	6.6
	.3125	2057	18.7	814	7.4

*Indicates allowable trench backfill heights in excess of 30 feet.

**Indicates allowable trench backfill heights in excess of 20 feet.

Note: With 90% compaction, allowable trench backfill heights for all diameters and wall thicknesses of pipe shown in above table exceed 30 ft.

[1]Values of Pv and h shown are calculated with the maximum allowable deflection of the installed pipe being 5% of the original undeflected diameter.

[2]Trench loading capabilities based on "Ring Deflection of Buried Pipes" by Reynold K. Watkins and Albert B. Smith. Soil weight used was 110 lbs./cu. ft.

[3]Allowable fill heights for soils having unit weights other than 110 lbs./cu. ft. may be calculated by dividing the allowable Pv value shown for a given size and class of pipe by the design soil weight.

[4]Allowable Pv values shown represent the maximum vertical in place loading, either dead or a combined dead and live load, to which the particular diameter and class of pipe should be subjected for the degree of compaction provided.

[5]Percent compaction shown for each table is the percentage of standard density as determined in accordance with the requirements of either ASTM D698 or AASHO T99.

[6]Allowable trench backfill heights for diameters and wall thicknesses not shown are available upon request.

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NWP0032949

EXHIBIT S-24-1.4

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BPT 11-68

Specifications and Design Details and Dimensions for

CEMENT-MORTAR LINED & COATED STEEL PIPE 4" thru 48"

BFALL

PIPE & TANK CORPORATION

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NWP0032951

The material and tables found in this publication are issued for the purpose of establishing design criteria, design details and dimensions, and external load capabilities for Cement-Mortar Lined and Coated Steel Pipe for internal working pressures up to 400 psi for use in the transmission and distribution of water and for sewer force mains.

For additional information concerning the material contained in this standard, please write to Beall Pipe & Tank Corporation, Welded Steel Pipe Division, 12005 North Burgard, Portland, Oregon 97203 or any of the sales offices listed on the back of this publication.

Issued by
BEALL PIPE & TANK CORPORATION
12005 North Burgard
Portland, Oregon 97203

NWP0032952

INDEX

A. GENERAL

1. Scope

This specification is the Beall Pipe & Tank Corporation standard specification for the design, fabrication, coating and lining of Cement-Mortar lined and Cement-Mortar coated Steel Pipe, 4" thru 48", for use in the transmission and distribution of water and for sewer force mains.

2. Submittals

The Contractor shall provide joint details for each size and class and line layouts or line schedules which indicate the location of each section of pipe and each special fitting to be furnished. These details and drawings shall be submitted to the Engineer for approval prior to fabrication.

3. Manufacturer

The pipe shall be manufactured by a firm which has had at least three years' successful experience in the manufacture of cement-mortar lined and cement-mortar coated pipe.

4. Components

The pipe shall consist of the following component parts: a welded steel, sheet or plate, cylinder with joints formed integrally with the steel cylinder; a dense cement-mortar lining; a dense concentric, steel-reinforced exterior mortar coating; a self-centering bell and spigot joint with a circular reformed elastomeric gasket, so designed that the joint will be watertight under all conditions of service. Maximum laying length of pipe sections shall be 40 feet.

B. STEEL CYLINDERS

1. Material

Cylinders shall be fabricated from hot-rolled, carbon steel sheets or plates, conforming to the requirements of the latest revision of A.S.T.M. Designation A 570 Grade B or C, or A.S.T.M. Designation A 415, except that the carbon content may be 0.25%. Plates shall conform to the requirements of A.S.T.M. Designation A 283 Grade B or C.

2. Fabrication

Sheets or plates shall be fabricated into cylinders with either longitudinal or helical seams. All longitudinal or helical seams shall be butt welds and shall be made by an automatic process, either submerged arc or electric resistance, which produces welds with tensile strength equal to that of the sheet or plate.

3. Steel Area

Unless otherwise specified, the wall thickness of the steel cylinder shall be computed on the basis of having a minimum stress of 16,500 PSI in the steel at the design pressure, but shall be not less than the thickness of No. 14 gage.

4. Testing

After each cylinder is completed, but prior to lining or coating, it shall be tested hydrostatically to a minimum circumferential tensile stress equal to 75 percent of its specified minimum yield strength. Cylinders which show any leakage under test shall be rewelded at the points of leakage and subjected to another hydrostatic test. The finished steel cylinder shall be completely watertight under the required test pressure.

C. JOINTS

1. Fabrication

The joint shall be an O-Ring bell and spigot type, utilizing a rubber gasket to achieve a watertight seal. Bell and spigot ends shall be formed integrally with the steel cylinder by sizing with a machine swage or die, or by rolling with suitable rolling equipment.

Bell and spigot ends shall be circular in shape and shall be so designed that the gasket will be restrained or confined to an annular space in such a manner that movement of the pipe or hydrostatic pressure cannot displace the gasket. Compression of the gasket in joint-closure position shall not be dependent upon water pressure in the pipe, and the compressed gasket shall substantially fill the annular space and effect a watertight seal. The gasket shall be of such size that when the outer surface of the spigot and the inner surface of the bell come into contact at some portion of their peripheries, the deformation in the gasket shall not exceed 50 percent at the point of contact and at the diametrically opposite point shall not be less than 15 percent of the stretched gasket diameter. The gasket shall be the sole element of the joint dependent upon to provide watertightness. The difference in circumferential measurement between the outside circumference of the spigot and the inside circumference of the bell shall be 0.060 inch minimum and 0.200 inch maximum as measured at the edge of a compressed gasket at nominal joint-closure position. The unlined interior surface of the bell and the uncoated exterior surface of the spigot shall be protected by a corrosion-resistant paint.

2. Rubber Gaskets

The gasket sealing the joint shall be a continuous ring made of a special composition rubber not subject to biologic degradation. The length of the gasket shall be volumetrically determined so that it will fill the joint recess provided.

The gasket shall be the sole element depended upon to make the joint watertight. Cement mortar used to complete the joint-making shall not be depended upon for watertightness.

The rubber compound shall contain no factice, reclaimed rubber, or any deleterious substance. All rubber gaskets shall be extruded or molded and cured in such a manner that any cross-section will be dense, homogenous, and free from porosity, blisters, pitting, and other imperfections. The gaskets shall be extruded or molded with smooth surfaces to the specified diameter.

The rubber compound shall meet the following physical requirements when tested in accordance with the applicable sections of Federal Test Method Standard No. 601 and appropriate ASTM Methods of Test as indicated:

(a) Natural Rubber (by volume) min. %	65
(b) Tensile Strength, PSI, min. ASTM D 412	3,000
(c) Elongation at rupture, percentage, min. ASTM D 412	500
(d) Shore Surometer, Type A (center o preferred) ASTM D 676 (the test shall be performed on the flat cross-section of a ½" length of gasket).	55+5
(e) Compression Set, percentage or original deflection, max. Method B (½" long section of gasket, constant deflection, 22 hours at 158°F.) ASTM D 395.	20
(f) Accelerated aging in air (96 hours at 158°F.) ASTM D 573. Tensile strength, percentage of orig. strength, min.	80
(g) Water absorption by weight, percentage, max. (24 hours at 158°F.)	1.5
(h) Acetone extract, percentage, max. ASTM D 297	15
(i) Specific gravity, ASTM D 297	1.10 to 1.20

All gaskets shall be stored in a cool, well-ventilated place. During shipment and storage, the gaskets shall also be protected from the direct rays of the sun.

D. CEMENT MORTAR LINING AND COATING

1. Materials

a. **Cement:** Cement shall conform to the requirements of the current ASTM Designation C-150, Type I or II. Cement shall be properly stored, and no cement that has become lumpy shall be used.

b. **Aggregates:** All sand used in mortar concrete shall conform to the current ASTM Designation C-33, Fine Aggregate, except that the gradation may be slightly modified to provide a lining and coating of maximum density.

c. **Water:** Water used for mixing mortar shall be clear and free from silt, oil, acid, strong alkalies, vegetable matter or the other impurities.

d. **Wire Reinforcement:** Wire used for the helically wound reinforcement of the mortar coating shall conform to the requirements of Federal Specification QQ-W-418 for Wire, Steel, Cold Drawn for Concrete Reinforcement.

2. Cement-Mortar Lining

Cement mortar for lining shall consist of one part of cement to not more than three parts of fine aggregate, by volume. The lining shall be spun in the cylinder to a nominal thickness of 5/16" for pipe size 4" through 12", 3/8" for pipe size 14" through 18", 1/2" for pipe size 20" through 42".

Gage rings shall be used at the ends of the pipe to control the thickness. External round-up rings, when required, shall be placed around the cylinder prior to spinning to assure roundness of the cylinders and uniformity of lining thickness. After the concrete has been in the cylinder, it shall be revolved at a speed which will cause the concrete to level out to a uniform thickness throughout the cylinder. The spinning shall be continued until the lining is thoroughly compacted and surplus water removed. The finished lining shall be smooth and uniform throughout.

When the pipe is removed from the spinning machine and transported to the curing area, it shall be supported in a suitable manner so that there will be no appreciable bending through the length of the section.

Before the exterior coating is applied, the lining shall be kept moist for a minimum period of 24 hours after spinning. This may be accomplished by tightly sealing the ends of the cylin-

der with a waterproof membrane to retain the moisture in the concrete. Steam curing for six hours may be used in lieu of the 24 hours of moist curing.

3. Cement-Mortar Coating

The concrete mixture for the exterior coating shall consist of one part cement to not more than three parts of aggregate, by volume. Rebound may be reclaimed and used as aggregate.

The coating shall be applied by means of high velocity, steam jet, feeder belt or other approved means. The finished coating shall be dense, uniform, and firm, shall adhere tightly to the outside surface of the pipe, and shall be free from deleterious flaws, holidays, or other injurious surface imperfections. It shall be of such thickness as to provide a minimum cover 3/16" over the reinforced wire rod.

The steel reinforcement in the mortar coating shall consist of a cold drawn steel wire (see Section D 1.d: Wire Reinforcement) helically wound onto the pipe concurrently with the application of the cement-mortar near the center of the coating. Helically wound wire shall be not less than the thickness of No. 14 gage, and shall be wound at a minimum spacing of 1¼ inches.

After completion of the coating operation, the pipe shall be transported to the curing yard. It shall be suitably supported during handling and curing to prevent damage to the coating.

4. Tolerances

The following tolerances shall apply to completed pipe:

(a) The lining thickness shall not vary more than plus or minus 25% from that specified.

(b) All reinforcement shall be covered with a minimum thickness of 3/16 inch of cement mortar.

5. Curing

Mortar lining and coating shall be water cured for a minimum period of six days or steam cured for thirty-six hours, after which time it may be delivered to the trench. Pipe shall not be stored, either in the yard or in the field, for any extended period of time under conditions which would cause injurious drying out, or when temperatures are below 35°.

6. Repair

Any defective area in the lining shall be removed to the pipe wall, and the area shall be repaired with mortar of the same properties.

E. BENDS & SPECIALS

1. Unsymmetrical Joint Closures

Laying of pipe to curved alignment by means of unsymmetrical closure of the joint shall be permitted as follows:

A joint deflection of ¾" for pipe sizes 4" through 24" shall be permitted by pulling the joint ¾" on one side from the normal ¼" wide mortar space; a joint deflection of 1" for pipe size 24" and larger shall be permitted by reducing the normal ½" wide mortar space to ¼" on one side and increasing the mortar space to 1" on the opposite side. However, the angular deflection at bell and spigot joints shall in no case exceed 5 degrees.

For the purpose of reducing the angular deflection to joints, and for closure sections, pipe sections of shorter than standard lengths may be used.

2. Bends

Where curves are required which have a shorter radius than can be obtained by deflecting pipe at the joints, beveled ends can be furnished for deflection to 5 degrees in most diameters. Where indicated on the drawings, short radius bends shall be fabricated from steel cylinders. Bends shall be mortar lined and coated. The design of such bends shall be approved by the Engineer prior to fabrication.

3. Special Fittings

Special fittings such as wyes, tees and crosses shall be constructed of steel cylinders and shall be mortar lined and coated. Fittings shall be equal in strength to the abutting pipe sections, and the design shall be approved by the Engineer prior to fabrication.

4. Outlets

Outlets shall be built into the wall of the pipe for blow-offs, branches, air valves and access manholes. They shall be made of cast or fabricated steel of suitable design and securely welded to the cylinder before being mortar coated. The cylinder shall be reinforced, as necessary, for the opening. The design of such outlets shall be approved by the Engineer prior to fabrication.

5. Tension Joints

Pipe ends shall be prepared for tension joints as shown on the plans and as designated by the Engineer. The tension joint, will be designed by the Engineer, with a cylinder and welds of sufficient strength to withstand the longitudinal forces due to closed valves, reducers, curved alignment and steep slopes. Shop drawings, showing the design of tension sections and design calculations of the forces the pipe will safely withstand, shall be submitted to the Engineer for approval prior to manufacture of these sections.

6. Testing

Completed special fittings, short joint, utilizing cylinders previously tested as described under Section B-4, shall not require additional testing.

F. MARKING HANDLING & SHIPPING

1. Marking

Each length of pipe shall be marked with paint on the spigot end with numbers corresponding to the shop drawings to indicate its position in the line. The markings shall be on the inside and/or outside of the pipe with legible lettering. All beveled pipe shall be marked with the amount of bevel. On specials such as bevels, reducers, tees, and bends, the top shop center line and top field center line shall be marked on the ends of the pipe.

Concrete coated pipe shall be marked with the class of pipe, and each pipe shall have a shop number marked so that it may easily be identified in the storage yard.

2. Bracing

Internal bracing shall be placed at the ends of the pipe and elsewhere, if necessary, to prevent the pipe from exceeding 0.5 percent out-of-roundness measured on the pipe diameter, and all such bracing required to maintain roundness shall remain in place until the pipe has been delivered to the trench site.

3. Handling

The pipe shall not be dropped or subjected to any unnecessary jar, impact or other treatment that might crack the shell or otherwise damage the pipe. Any unit of pipe that in the opinion of the Engineer is damaged beyond repair by the Contractor shall be replaced by another unit reinforced for the same or greater head. Any pipe that is damaged and repairable shall be repaired in the field, or at the direction of the Engineer, returned to the manufacturing plant for repair.

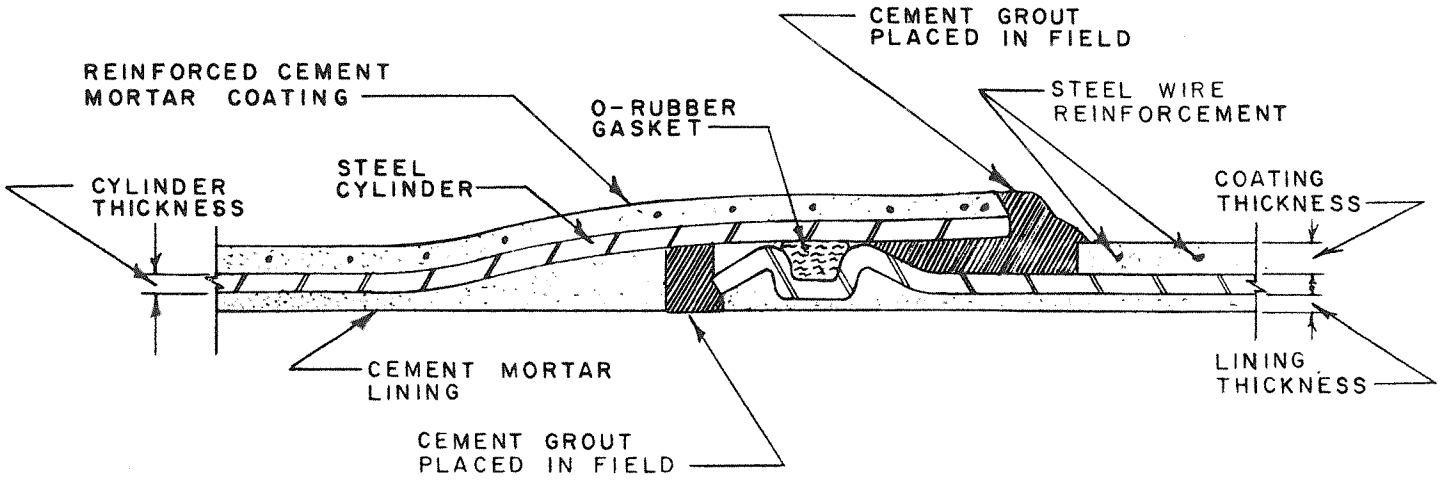
4. Shipping

An adequate cover shall be placed on each end of each pipe shipped by rail car and on the leading end of each pipe transported by truck.

STANDARD DESIGN TABLES

TABLE 1

NOMINAL DIAMETER (inches)	CYLINDER OUTSIDE DIAMETER (inches)[1]	LINING THICKNESS (inches)[4]	COATING THICKNESS (inches)[4]	CLASS 100 PSI		CLASS 150 PSI	
				CYLINDER THICKNESS (inches)[2]	SHIPPING WEIGHT (lbs./ft.)[5]	CYLINDER THICKNESS (inches)[2]	SHIPPING WEIGHT (lbs./ft.)[5]
4	4 1/2	5/16	1/2	0.0747	15.09	0.0747	15.09
6	6 5/8	5/16	1/2	0.0747	22.06	0.0747	22.06
8	8 5/8	5/16	1/2	0.0747	30.52	0.0747	30.52
10	10 3/4	5/16	1/2	0.0747	35.70	0.0747	35.70
12	12 3/4	5/16	1/2	0.0747	48.90	0.0747	48.90
14	15	3/8	5/8	0.0747	69.39	0.0747	69.39
16	17	3/8	5/8	0.0747	80.30	0.1046	85.62
18	19	3/8	5/8	0.0747	95.17	0.1046	99.12
20	21 25/32	1/2	3/4	0.0747	119.23	0.1046	125.74
21	22 25/32	1/2	3/4	0.0747	125.49	0.1046	132.51
24	25 3/4	1/2	3/4	0.1046	146.53	0.1345	156.55
27	28 25/32	1/2	3/4	0.1046	168.80	0.1345	174.92
30	31 7/8	1/2	3/4	0.1046	186.38	0.1875	211.32
33	34 7/8	1/2	3/4	0.1046	203.96	0.1875	230.55
36	37 7/8	1/2	3/4	0.1345	229.24	0.1875	250.31
39	40 7/8	1/2	3/4	0.1345	247.43	0.1875	270.17
42	43 7/8	1/2	3/4	0.1875	290.05	0.2500	319.16
48	49 7/8	1/2	3/4	0.1875	329.82	0.2500	362.92



NOTES:

[1]In the nominal diameter range of 14" thru 48", cylinder outside diameters other than those shown are available upon request.

[2]Required cylinder thicknesses for welded steel pipe shown in the accompanying tables are based on the formula:

$$t = \frac{(P)\ (D)}{2S}$$ (Minimum t shall not be less than 14 ga.)

where: t = Required cylinder thickness, in inches
P = Internal working pressure of pipe, in psi
D = Outside diameter of cylinder, in inches
S = Allowable steel design stress, 16,500 psi.
S is determined by the yield point of the grade of steel being used utilizing a safety factor of 2.

$$S \text{ allowable} = \frac{\text{Yield Point}}{2}$$

For Table I, A.S.T.M. A 570 Grade C steel has been used. Yield Point equals 33,000 psi.

[3]Higher yield point steels are readily available and should be considered in preparing practical and economical pipeline designs, especially in the instances of large diameters, or high internal pressures, or both. Information on steels available are shown in Table II.

[4]Cement-mortar lining and coating thicknesses as shown in the above table are in accordance with the requirements of Federal Specification SS-P-385a for cement-mortar lined and coated steel pipe.

Allowable tolerances: Lining thickness ±25%
Coating thickness +1/4"
−0

[5]Shipping weights shown are approximate.

CLASS 200 PSI		CLASS 250 PSI		CLASS 300 PSI		CLASS 350 PSI		CLASS 400 PSI	
CYLINDER THICKNESS (inches)[2]	SHIPPING WEIGHT (lbs./ft.)[5]	CYLINDER THICKNESS (inches)[2]	SHIPPING WEIGHT (lbs./ft.)[5]	CYLINDER THICKNESS (inches)[2]	SHIPPING WEIGHT (lbs./ft.)[5]	CYLINDER THICKNESS (inches)[2]	SHIPPING WEIGHT (lbs./ft.)[5]	CYLINDER THICKNESS (inches)[2]	SHIPPING WEIGHT (lbs./ft.)[5]
0.0747	15.09	0.0747	15.09	0.0747	15.09	0.0747	15.09	0.0747	15.09
0.0747	22.06	0.0747	22.06	0.0747	22.06	0.0747	22.06	0.1046	24.09
0.0747	30.52	0.0747	30.52	0.1046	33.20	0.1046	33.20	0.1046	33.20
0.0747	35.70	0.1046	38.96	0.1046	38.96	0.1345	42.13	0.1345	42.13
0.1046	52.84	0.1046	52.84	0.1345	56.77	0.1345	56.77	0.1875	63.75
0.1046	74.92	0.1345	79.22	0.1345	79.22	0.1875	87.22	0.1875	87.22
0.1046	85.62	0.1345	91.71	0.1875	100.63	0.1875	100.63	0.2500	111.00
0.1345	106.35	0.1875	116.65	0.1875	116.65	0.2500	130.19	0.2500	130.19
0.1345	132.51	0.1875	144.51	0.2500	158.40	0.2500	158.40	0.2500	158.40
0.1345	139.59	0.1875	152.13	0.2500	166.82	0.2500	166.82	0.3125	181.47
0.1875	170.75	0.2500	187.55	0.2500	187.55	0.3125	204.40	0.3125	204.40
0.1875	190.80	0.2500	209.85	0.3125	228.16	0.3125	228.16	0.3750	245.25
0.1875	210.67	0.2500	231.72	0.3125	251.94	0.3750	270.81	0.3750	270.81
0.2500	253.58	0.3125	275.71	0.3125	275.71	0.3750	296.36	0.4375	320.52
0.2500	275.44	0.3125	299.47	0.3750	321.91	0.4375	348.15	0.5000	372.82
0.2500	297.29	0.3125	323.22	0.3750	347.45	0.4375	375.77	0.5000	402.39
0.3125	347.00	0.3750	265.65	0.4375	403.42	0.5000	432.00	0.5625	462.85
0.3125	394.57	0.3750	302.07	0.5000	491.23	0.5625	526.20	0.6250	558.70

Yield Point and Tensile Strength Comparison for A.S.T.M. A283, A.S.T.M. A570 and A.P.I. 5LX

TABLE 2

STEEL SPECIFICATION	GRADE	YIELD POINT (MIN. PSI)	TENSILE STRENGTH (MIN. PSI)
A.S.T.M. A 283 (Plates)	A	24,000	45,000
	B	27,000	50,000
	C	30,000	55,000
	D	33,000	60,000
A.S.T.M. A 570 (Sheets & Coils)	A	25,000	45,000
	B	30,000	49,000
	C	33,000	52,000
	D	40,000	55,000
	E	42,000	58,000
A.P.I. 5LX (Sheets & Coils)	X42	42,000	60,000
	X46	46,000	63,000
	X52	52,000	66,000

ALLOWABLE TRENCH BACKFILL LOADING[1]

TABLE 3 90% COMPACTION[5]

NOMINAL DIAMETER (Inches)	CLASS 100 PSI Allowable Pv (psf)	CLASS 100 PSI Allowable h (feet)	CLASS 150 PSI Allowable Pv (psf)	CLASS 150 PSI Allowable h (feet)	CLASS 200 PSI Allowable Pv (psf)	CLASS 200 PSI Allowable h (feet)
12		*		*		*
14		*		*		*
16	3080	28.0	3300	30.0	3300	30.0
18	2640	24.0	2640	24.0	2640	24.0
20	3080	28.0	3080	28.0	3080	28.0
21	2860	26.0	2860	26.0	2860	26.0
22	2640	24.0	2640	24.0	2750	25.0
24	2420	22.0	2420	22.0	2420	22.0
26	2200	20.0	2310	21.0	2310	21.0
28	2200	20.0	2200	20.0	2200	20.0
30	2090	19.0	2123	19.3	2123	19.3
32	2079	18.9	2090	19.0	2090	19.0
33	2057	18.7	2057	18.7	2090	19.0
34	2057	18.7	2057	18.7	2057	18.7
36	1980	18.0	1980	18.0	2057	18.7
38	1980	18.0	1980	18.0	1980	18.0
39	1958	17.8	1980	18.0	1980	18.0
40	1980	18.0	1980	18.0	1980	18.0
42	1980	18.0	1980	18.0	1980	18.0
48	1815	16.5	1826	16.6	1859	16.9

*In Table 3, indicates allowable trench backfill heights in excess of 30 feet.

TABLE 4 85% COMPACTION[5]

12	3080	28.0	3080	28.0	3190	29.0
14		*		*		*
16	2420	22.0	2420	22.0	2420	22.0
18	2354	21.4	2365	21.5	2365	21.5
20	2310	21.0	2310	21.0	2310	21.0
21	2134	19.4	2134	19.4	2145	19.5
22	1914	17.4	1914	17.4	2024	18.4
24	1540	14.0	1540	14.0	1617	14.7
26	1375	12.5	1397	12.7	1430	13.0
28	1320	12.0	1320	12.0	1320	12.0
30	1232	11.2	1265	11.5	1265	11.5
32	1199	10.9	1232	11.2	1232	11.2
33	1177	10.7	1188	10.8	1232	11.2
34	1177	10.7	1188	10.8	1188	10.8
36	1144	10.4	1144	10.4	1177	10.7
38	1133	10.3	1133	10.3	1144	10.4
39	1133	10.3	1133	10.3	1133	10.3
40	1133	10.3	1133	10.3	1133	10.3
42	1100	10.0	1100	10.0	1100	10.5
48	1100	10.0	1100	10.0	1100	10.2

*In Table 4, indicates allowable trench backfill heights in excess of 30 feet.

TABLE 5 70% COMPACTION[5]

12		*		*		*
14		*		*		*
16		*		*		*
18	1837	16.7	1859	16.9	1936	17.6
20		*		*		*
21	2112	19.2	2112	19.2	2134	19.4
22	1859	16.9	1859	16.9	1980	18.0
24	1496	13.6	1518	13.8	1595	14.5
26	1133	10.3	1144	10.4	1232	11.2
28	924	8.4	935	8.5	990	9.0
30	781	7.1	825	7.5	825	7.5
32	660	6.0	704	6.4	781	7.1
33	605	5.5	649	5.9	726	6.6
34	550	5.0	594	5.4	660	6.0
36	506	4.6	528	4.8	550	5.0
38	451	4.1	473	4.3	506	4.6
39	440	4.0	451	4.1	484	4.4
40	429	3.9	429	3.9	462	4.2
42	385	3.5	418	3.8	473	4.3
48	275	2.5	330	3.0	363	3.3

*In Table 5, indicates allowable trench backfill heights in excess of 20 feet.

[1]Values of Pv and h shown are calculated with the maximum allowable deflection of the installed pipe being 2% of the original undeflected diameter.

[2]Trench loading capabilities based on "Ring Deflection of Buried Pipes" by Reynold K. Watkins and Albert B. Smith. Soil weight used was 110 lbs./cu. ft.

[3]Allowable fill heights for soils having unit weights other than 110 lbs./cu. ft. may be calculated by dividing the allowable Pv value shown for a given size and class of pipe by the design soil weight.

CLASS 250 PSI		CLASS 300 PSI		CLASS 350 PSI		CLASS 400 PSI	
Allowable Pv (psf)	Allowable h (feet)	Allowable Pv (psf)	Allowable h (feet)	Allowable Pv (psf)	Allowable h (feet)	Allowable Pv (psf)	Allowable h (feet)
	*		*		*		*
	*		*		*		*
3300	30.0		*		*		*
2860	26.0	2860	26.0	3080	28.0	3080	28.0
3300	30.0		*		*		*
2860	26.0	3080	28.0	3080	28.0	3190	29.0
2750	25.0	2860	26.0	2860	26.0	2970	27.0
2640	24.0	2640	24.0	2860	26.0	2860	26.0
2310	21.0	2310	21.0	2574	23.4	2816	25.6
2200	20.0	2420	22.0	2420	22.0	2574	23.4
2200	20.0	2266	20.6	2409	21.9	2409	21.9
2090	19.0	2112	19.2	2288	20.8	2431	22.1
2090	19.0	2101	19.1	2134	19.4	2376	21.6
2090	19.0	2090	19.0	2134	19.4	2332	21.2
2057	18.7	2101	19.1	2145	19.5	2376	21.6
2035	18.5	2068	18.8	2123	19.3	2244	20.4
2013	18.3	2046	18.6	2101	19.1	2178	19.8
2002	18.2	2024	18.4	2068	18.8	2123	19.3
2002	18.2	2046	18.6	2101	19.1	2189	19.9
1925	17.5	2013	18.3	2068	18.8	2123	19.3
3190	29.0	3300	30.0	3300	30.0		*
	*		*		*		*
2530	23.0	2860	26.0	2860	26.0		*
2464	22.4	2640	24.0	2805	25.5	2959	26.9
2420	22.0	2750	25.0	2750	25.0	2750	25.0
2211	20.1	2420	22.0	2420	22.0	2475	22.5
2024	18.4	2211	20.1	2211	20.1	2387	21.7
1815	16.5	1815	16.5	2046	18.6	2046	18.6
1485	13.5	1485	13.5	1672	15.2	2024	18.4
1375	12.5	1540	14.0	1540	14.0	1683	15.3
1276	11.6	1386	12.6	1540	14.0	1540	14.0
1232	11.2	1287	11.7	1386	12.6	1551	14.1
1265	11.5	1265	11.5	1342	12.2	1474	13.4
1254	11.4	1254	11.4	1298	11.8	1408	12.8
1254	11.4	1254	11.4	1320	12.0	1463	13.3
1188	10.8	1232	11.2	1276	11.6	1375	12.5
1177	10.7	1210	11.0	1254	11.4	1331	12.1
1177	10.7	1199	10.9	1232	11.2	1287	11.7
1188	10.8	1221	11.1	1254	11.4	1342	12.2
1144	10.4	1188	10.8	1243	11.3	1298	11.8
	*		*		*		*
	*		*		*		*
	*		*		*		*
2101	19.1	2101	19.1		*		*
	*		*		*		*
	*		*		*		*
1980	18.0	2200	20.0		*		*
1738	15.8	1738	15.8	2035	18.5	2035	18.5
1386	12.6	1386	12.6	1650	15.0	1958	17.8
1089	9.9	1320	12.0	1320	12.0	1628	14.8
902	8.2	1056	9.6	1309	11.9	1309	11.9
781	7.1	880	8.0	1067	9.7	1364	12.4
770	7.0	825	7.5	979	8.9	1232	11.2
759	6.9	759	6.9	891	8.1	1111	10.1
660	6.0	792	7.2	946	8.6	1210	11.0
583	5.3	682	6.2	836	7.6	1045	9.5
550	5.0	638	5.8	781	7.1	957	8.7
517	4.7	583	5.3	737	6.7	880	8.0
517	4.7	649	5.9	792	7.2	979	8.9
396	3.6	539	4.9	704	6.4	847	7.7

[4]Allowable Pv values shown represent the maximum vertical in place loading, either dead or a combined dead and live load, to which the particular diameter and class of pipe should be subjected for the degree of compaction provided.

[5]Percent compaction shown for each table is the percentage of standard density as determined in accordance with the requirements of either ASTM D698 or AASHO T99.

[6]Allowable trench backfill heights for diameters and wall thicknesses not shown are available upon request.

BPT STD 11-68
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NWP0032966

EXHIBIT S-24-1.5

BPT STD 12-68
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BPT 12-68

Specifications and
Design Details and
Dimensions for

CEMENT-MORTAR LINED & COAL-TAR ENAMEL COATED STEEL PIPE 4" thru 48"

PIPE & TANK CORPORATION
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NWP0032968

The material and tables found in this publication are issued for the purpose of establishing design criteria, design details and dimensions, and external load capabilities for Cement-Mortar Lined & Coal-Tar Enamel Coated Steel Pipe for internal working pressures up to 400 psi for use in the transmission and distribution of water and for sewer force mains.

For additional information concerning the material contained in this standard, please write to Beall Pipe & Tank Corporation, Welded Steel Pipe Division, 12005 North Burgard, Portland, Oregon 97203, or any of the sales offices listed on the back of this publication.

Issued by
BEALL PIPE & TANK CORPORATION
12005 North Burgard
Portland, Oregon 97203

NWP0032969

INDEX

NWP0032970

A. GENERAL

1. Scope

This specification is the Beall Pipe & Tank Corporation standard specification for the design, fabrication, coating and lining of cement-mortar lined and coal-tar enamel coated steel pipe, 4" thru 48", for use in the transmission and distribution of water and for sewer force mains.

2. Submittals

The Contractor shall provide joint details for each size and class, and line layouts or line schedules which indicate the location of each section of pipe and each special fitting to be furnished. These details and drawings shall be submitted to the Engineer for approval prior to fabrication.

3. Manufacturer

The pipe shall be manufactured by a firm which has had at least three years' successful experience in the manufacture of cement-mortar lined and cement-mortar coated pipe.

4. Components

The pipe shall consist of the following component parts: a welded steel, sheet or plate, cylinder with joints formed integrally with the steel cylinder; a dense cement-mortar lining; a dense concentric, steel-reinforced exterior mortar coating; a self-centering bell and spigot joint with a circular reformed elastomeric gasket, so designed that the joint will be watertight under all conditions of service. Maximum laying length of pipe sections shall be 40 feet.

B. STEEL CYLINDERS

1. Material

Cylinders shall be fabricated from hot-rolled, carbon steel sheets or plates, conforming to the requirements of the latest revision of A.S.T.M. Designation A 570 Grade B or C, or A.S.T.M. Designation A 415, except that the carbon content may be 0.25%. Plates shall conform to the requirements of A.S.T.M. Designation A 283 Grade B or C.

2. Fabrication

Sheets or plates shall be fabricated into cylinders with either longitudinal or helical seams. All longitudinal or helical seams shall be butt welds and shall be made by an automatic process, either submerged arc or electric resistance, which produces welds with tensile strength equal to that of the sheet or plate.

3. Steel Area

Unless otherwise specified, the wall thickness of the steel cylinder shall be computed on the basis of having a minimum stress of 16,500 PSI in the steel at the design pressure, but shall be not less than the thickness of No. 14 gage.

4. Testing

After each cylinder is completed, but prior to lining or coating, it shall be tested hydrostatically to a minimum circumferential tensile stress equal to 75 percent of its specified minimum yield strength. Cylinders which show any leakage under test shall be rewelded at the points of leakage and subjected to another hydrostatic test. The finished steel cylinder shall be completely watertight under the required test pressure.

C. JOINTS

1. Fabrication

The joint shall be an O-Ring bell and spigot type, utilizing a rubber gasket to achieve a watertight seal. Bell and spigot ends shall be formed integrally with the steel cylinder by sizing with a machine swage or die, or by rolling with suitable rolling equipment.

Bell and spigot ends shall be circular in shape and shall be so designed that the gasket will be restrained or confined to an annular space in such a manner that movement of the pipe or hydrostatic pressure cannot displace the gasket. Compression of the gasket in joint-closure position shall not be dependent upon water pressure in the pipe, and the compressed gasket shall substantially fill the annular space and effect a watertight seal. The gasket shall be of such size that when the outer surface of the spigot and the inner surface of the bell come into contact at some portion of their peripheries, the deformation in the gasket shall not exceed 50 percent at the point of contact and at the diametrically opposite point shall not be less than 15 percent of the stretched gasket diameter. The gasket shall be the sole element of the joint dependent upon to provide watertightness. The difference in circumferential measurement between the outside circumference of the spigot and the inside circumference of the bell shall be 0.060 inch minimum and 0.200 inch maximum as measured at the edge of a compressed gasket at nominal joint-closure position. The unlined interior surface of the bell and the uncoated exterior surface of the spigot shall be protected by a corrosion-resistant paint.

2. Rubber Gaskets

The gasket sealing the joint shall be a continuous ring made of a special composition rubber not subject to biologic degradation. The length of the gasket shall be volumetrically determined so that it will fill the joint recess provided.

The gasket shall be the sole element depended upon to make the joint watertight. Cement mortar used to complete the joint-making shall not be depended upon for watertightness.

The rubber compound shall contain no factice, reclaimed rub-

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ber or any deleterious substance. All rubber gaskets shall be extruded or molded and cured in such a manner that any cross-section will be dense, homogenous, and free from porosity, blisters, pitting and other imperfections. The gaskets shall be extruded or molded with smooth surfaces to the specified diameter.

The rubber compound shall meet the following physical requirements when tested in accordance with the applicable sections of Federal Test Method Standard No. 601 and appropriate ASTM Methods of Test as indicated:

(a) Natural Rubber (by volume) min. %	65
(b) Tensile Strength, PSI, min. ASTM D 412	3,000
(c) Elongation at rupture, percentage, min. ASTM D 412	500
(d) Shore Surometer, Type A (center o preferred) ASTM D 676 (the test shall be performed on the flat cross-section of a ½" length of gasket).	55+5
(e) Compression Set, percentage or original deflection, max. Method B (½" long section of gasket, constant deflection, 22 hours at 158°F.) ASTM D 395.	20
(f) Accelerated aging in air (96 hours at 158°F.) ASTM D 573. Tensile strength, percentage of orig. strength, min.	80
(g) Water absorption by weight, percentage, max. (24 hours at 158°F.)	1.5
(h) Acetone extract, percentage, max. ASTM D 297	15
(i) Specific gravity, ASTM D 297	1.10 to 1.20

All gaskets shall be stored in a cool, well-ventilated place. During shipment and storage, the gaskets shall also be protected from the direct rays of the sun.

D. CEMENT-MORTAR LINING

1. Materials

a. **Cement:** Cement shall conform to the requirements of the current ASTM Designation C-150, Type I or II. Cement shall be properly stored, and no cement that has become lumpy shall be used.

b. **Aggregates:** All sand used in mortar concrete shall conform to the current ASTM Designation C-33, Fine Aggregate, except that the gradation may be slightly modified to provide a lining and coating of maximum density.

c. **Water:** Water used for mortar shall be clear and free from silt, oil, acid, strong alkalies, vegetable matter or other impurities.

2. Lining Application

Cement mortar for lining shall consist of one part of cement to not more than three parts of fine aggregate, by volume. The lining shall be spun in the cylinder to a nominal thickness of 5/16" for pipe size 4" through 12", 3/8" for pipe size 14" through 18", ½" for pipe size 20" through 42".

Gage rings shall be used at the ends of the pipe to control the thickness. External round-up rings, when required, shall be placed around the cylinder prior to spinning to assure roundness of the cylinders and uniformity of lining thickness. After the concrete has been placed in the cylinder, it shall be revolved at a speed which will cause the concrete to level out to a uniform thickness throughout the cylinder. The spinning shall be continued until the lining is thoroughly compacted and surplus water removed. The finished lining shall be smooth and uniform throughout.

When the pipe is removed from the spinning machine and transported to the curing area, it shall be supported in a suitable manner so that there will be no appreciable bending through the length of the section.

Before the exterior coating is applied, the lining shall be kept moist for a minimum period of 24 hours after spinning. This may be accomplished by tightly sealing the ends of the cylinder with a waterproof membrane to retain the moisture in the concrete. Steam curing for six hours may be used in lieu of the 24 hours of moist curing.

3. Curing

Mortar lining shall be water cured for a minimum period of six (6) days or steam cured for thirty-six (36) hours before proceeding with the exterior coal-tar enamel coating operation. Pipe shall not be stored in the yard or in the field for any extended period of time under conditions which would cause injurious drying out or when temperatures are below 35°F.

4. Tolerance

The completed lining thickness shall not vary more than plus or minus 25% from that specified in Table I Section B 3, of these specifications.

E. COAL-TAR ENAMEL COATING

1. Materials

a. **Coal-Tar Primer:** The primer shall consist of processed coal-tar pitch and refined coal-tar oils only, blended to produce a liquid coating which may be applied cold by brushing or spraying and which will produce an effective bond between the metal and subsequent coating of coal-tar enamel. Primer shall contain no benzol or other toxic, or highly volatile solvents and, no added pigments or inert fibers.

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b. **Coal-Tar Enamel:** The enamel used for the exterior coating shall be composed of a specially processed coal-tar pitch combined with an inert mineral filler. No asphalt of either petroleum or natural base shall be included as part of the enamel used. The enamel shall conform to the requirements of the AWWA Standard C-203-66, Section 2.2, Table I which are as follows:

CHARACTERISTICS OF AWWA COAL-TAR ENAMEL

TEST	Minimum	Maximum
Softening point—ASTM D36-64T	220°F	...
Filler (ash)—ASTM D271-64	25%	35%
Fineness filler, through 200 mesh—ASTM D546-55	90%	...
Specific gravity at 25°C—ASTM D71-52	1.40	1.60
*Penetration—ASTM D5-65		
At 77°F—100-g weight—5 sec.	10	20
At 115°F—50-g weight—5 sec.	15	55
High-temperature test—at 160°F (sag)—AWWA C203, Sec. 2.4.4 (1)	...	2/32"
Low-temperature test—at -20°F (cracking)—AWWA C203, Sec. 2.4.4 (2)	...	None
†Deflection test (initial heating)—AWWA C203, Sec. 2.4.4 (3)		
Initial crack	0.8"	...
Disbonded area	...	3.0 sq.in.
†Deflection test (after heating)—AWWA C203, Sec. 2.4.4 (4)		
Initial crack	0.6"	...
Disbonded area	...	5.0 sq.in.
†Impact test—at 77°F—650-g ball, 8-ft. drop—AWWA C203, Sec. 2.4.4 (6)		
Direct impact—disbonded area	...	10.0 sq.in.
Indirect impact—disbonded area	...	2.0 sq.in.
Peel test—AWWA C203, Sec. 2.4.4. (5)	no peeling	

*For anticipated minimum temperature exposures between 20°F and -20°F, use penetration of 15 to 20 at 77°F.

†Choice of bond testing methods A or B by deflection (before heating), by deflection (after heating), or by impact shall depend upon laboratory equipment available.

2. Coating Application

After completion of the mortar lining and curing operation, the exterior surface of the cylinder shall be thoroughly cleaned by blasting, and all foreign matter not removable by blasting shall be removed by suitable means. All blasted steel surfaces shall be dry and cleaned of dust and grit and shall be primed immediately following blasting and cleaning. The primer shall be applied by hand brushing, air gun spraying or spraying-and-brushing in accordance with instructions for application as supplied by the manufacturer of the primer.

After application, the coal-tar priming coat shall be uniform and free from floods, runs, sags, drips, holidays or bare spots. Any bare spots or holidays shall be recoated with an additional application of primer. All runs, sags, floods or drips shall be removed by scraping and cleaning and the clean area repaired.

The primed steel surfaces to be enameled shall be dry and

clean at the time the enamel is applied. The coal-tar enamel shall be applied by pouring on the revolving pipe and spreading to the specified 3/32 of an inch thickness. Enamel shall be applied so that each spiral resulting from the spreading operations shall overlap the preceding spiral, producing a continuous coat free from defects.

3. Tolerance

The completed coating thickness shall be 3/32 of an inch and the allowable variation in thickness shall not exceed **plus or minus** 1/32 of an inch.

F. WRAPPING

1. Materials

a. **Asbestos Coal-Tar Saturated Felt:** The wrapper shall be composed of an asbestos felt having an asbestos content of not less than 85 percent of the desaturated felt with suitable binder and a weight of not less than 12 pounds nor more than 15 pounds per 100 square feet.

b. **Kraft Paper:** The kraft paper shall be an 80 pound, 100 percent sulphate, smooth paper.

2. Wrapping Application

During the coal-tar enamel coating stage of the operation, the pipe shall be wrapped with a pipe line felt as specified in section F 1.a of these specifications. The asbestos coal-tar saturated felt shall be spirally applied by means of a continuous endfeed machine under sufficient tension to be free of wrinkles and buckles and to definitely bond the felt to the exterior coating of the pipe. The lap of the felt on succeeding spirals shall not be less than ½ inch.

Over the bonded asbestos felt wrapper shall be applied a spiral wrapping of kraft paper as specified in section F 1.b of these specifications.

Double wrapping with asbestos felt, the use of a fiberglass mat wrap or combinations of felt, fiberglass and kraft paper as specified by the Purchaser are possible alternates.

G. BENDS & SPECIALS

1. Joint Deflection

Laying of pipe to curved alignment may be accomplished by deflecting the individual pipe sections at the joints in accordance with Table A on the next page.

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TABLE A

Nominal Pipe Diameter	Allowable Joint Deflection[1]	Nominal Pipe Diameter	Allowable Joint Deflection[1]
4″	5° 00′	26″	2° 04′
6″	5° 00′	27″	2° 00′
8″	4° 46′	28″	1° 54′
10″	3° 52′	30″	1° 48′
12″	3° 16′	32″	1° 42′
14″	2° 48′	33″	1° 38′
16″	2° 28′	34″	1° 36′
18″	2° 14′	36″	1° 30′
20″	1° 58′	38″	1° 26′
21″	1° 54′	39″	1° 24′
22″	1° 48′	40″	1° 22′
24″	1° 40′	42″	1° 18′
		48″	1° 10′

[1]The angular deflection at bell and spigot joints shall in no case exceed 5 degrees. For the purpose of reducing the angular deflection to joints, and for closure sections, pipe sections of shorter than standard 40 foot lengths may be used.

2. Bends

Where curves are required which have a shorter radius than can be obtained by deflecting pipe at the joints, beveled ends can be furnished for deflection to 5 degrees in most diameters. Where indicated on the drawings, short radius bends shall be equal in strength to the abutting pipe sections. After fabrication, the bends shall be cement-mortar lined in accordance with Section D 3. of these specifications. Upon completion of the lining-curing phase, the bends shall be coal-tar enamel coated and wrapped as specified in Sections E 2. and F 2. of these specifications. The design of such bends shall be approved by the Engineer prior to fabrication.

3. Special Fittings

Special fittings such as wyes, tees, crosses and etc., shall be constructed of steel cylinders and shall be mortar lined and coal-tar enamel coated and wrapped after fabrication. Fittings shall be equal in strength to the abutting pipe sections. The design of such fittings shall be approved by the Engineer prior to fabrication.

4. Outlets

Outlets shall be built into the wall of the pipe for blow-offs, branches, air valves and access manholes. They shall be made of cast or fabricated steel of suitable design and securely welded to the cylinder before being mortar lined and coal-tar enamel coated and wrapped. The cylinder shall be reinforced, as necessary, for the opening. The design of such outlets shall be approved by the Engineer prior to fabrication.

5. Tension Joints

Pipe ends shall be prepared for tension joints as shown on the plans and as designated by the Engineer. The tension joint, will be designed by the Engineer, with a cylinder and welds of

sufficient strength to withstand the longitudinal forces due to closed valves, reducers, curved alignment and steep slopes. Shop drawings, showing the design of tension sections and design calculations of the forces the pipe will safely withstand, shall be submitted to the Engineer for approval prior to manufacture of these sections.

6. Testing

Completed special fittings, bends and short lengths, utilizing cylinders previously tested in accordance with the requirements of Section B 4. of these specifications, shall not require additional testing.

H. MARKING HANDLING & SHIPPING

1. Marking

Each length of pipe shall be marked with paint on the spigot end with numbers corresponding to the shop drawings to indicate its position in the line. The marking shall be on the inside and/or outside of the pipe with legible lettering. All beveled pipe shall be marked with the amount of bevel. On specials such as bevels, reducers, tees and bends, the top shop center line and top field center line shall be marked on the ends of the pipe.

Concrete lined pipe shall be marked with the class of pipe, and each pipe shall have a shop number marked so that it may easily be identified in the storage yard.

2. Bracing

Internal bracing shall be placed at the ends of the pipe and elsewhere, if necessary, to prevent the pipe from exceeding 0.5 percent out-of-roundness measured on the pipe diameter, and all such bracing required to maintain roundness shall remain in place until the pipe has been delivered to the trench site.

3. Handling

The pipe shall not be dropped or subjected to any unnecessary jar, impact, or other treatment that might crack the shell or otherwise damage the pipe. Any unit of pipe that in the opinion of the Engineer is damaged beyond repair by the Contractor shall be replaced by another unit reinforced for the same or greater head. Any pipe that is damaged and repairable shall be repaired in the field, or at the direction of the Engineer, returned to the manufacturing plant for repair.

4. Shipping

An adequate cover shall be placed on each end of each pipe shipped by rail car and on the leading end of each pipe transported by truck.

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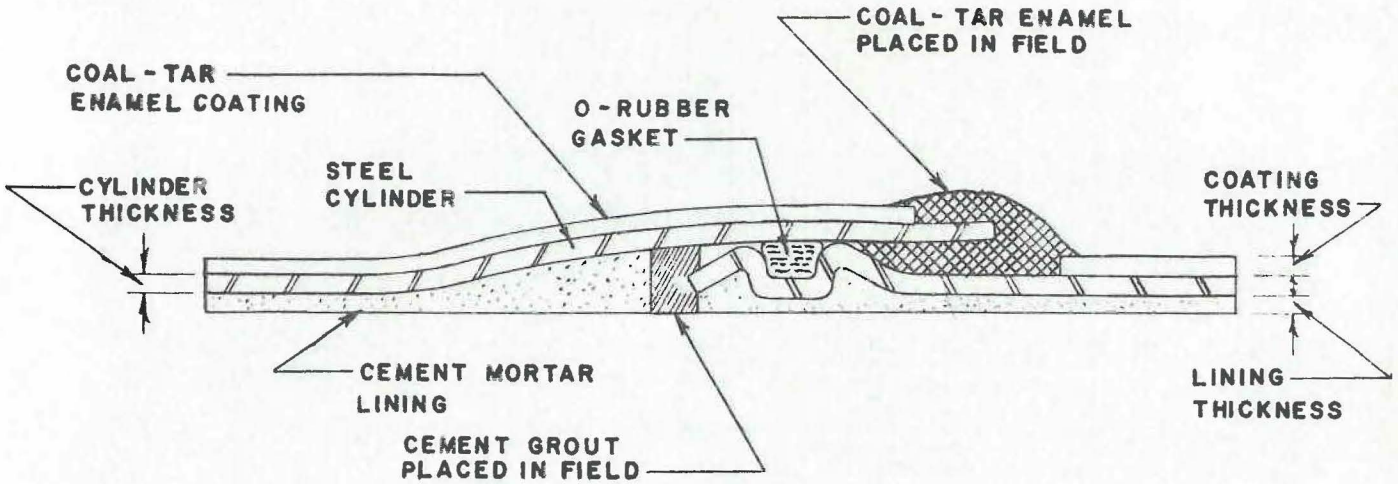
STANDARD DESIGN TABLES

TABLE 1

NOMINAL DIAMETER (inches)	CYLINDER OUTSIDE DIAMETER (inches)[1]	LINING THICKNESS (inches)[4]	CLASS 100 PSI		CLASS 150 PSI		CLASS 200 PSI	
			CYLINDER THICKNESS (inches)[2]	SHIPPING WEIGHT (lbs./ft.)[5]	CYLINDER THICKNESS (inches)[2]	SHIPPING WEIGHT (lbs./ft.)[5]	CYLINDER THICKNESS (inches)[2]	SHIPPING WEIGHT (lbs./ft.)[5]
4	4 1/2	5/16	0.0747	9.35	0.0747	9.35	0.0747	9.35
6	6 5/8	5/16	0.0747	14.04	0.0747	14.04	0.0747	14.04
8	8 5/8	5/16	0.0747	18.44	0.0747	18.44	0.0747	18.44
10	10 3/4	5/16	0.0747	22.98	0.0747	22.98	0.0747	22.98
12	12 3/4	5/16	0.0747	27.25	0.0747	27.25	0.1046	31.46
14	15	3/8	0.0747	32.06	0.0747	32.06	0.1046	40.26
16	17	3/8	0.0747	36.33	0.1046	45.43	0.1046	45.43
18	19	3/8	0.0747	40.60	0.1046	50.77	0.1345	56.66
20	21 25/32	1/2	0.0747	61.15	0.1046	67.93	0.1345	74.63
21	22 25/32	1/2	0.0747	64.02	0.1046	71.04	0.1345	78.12
24	25 3/4	1/2	0.1046	80.31	0.1345	88.23	0.1875	104.83
27	28 25/32	1/2	0.1046	89.76	0.1345	98.61	0.1875	117.17
30	31 7/8	1/2	0.1046	99.40	0.1875	129.75	0.1875	129.75
33	34 7/8	1/2	0.1046	108.77	0.1875	141.99	0.2500	161.25
36	37 7/8	1/2	0.1345	131.10	0.1875	154.20	0.2500	175.12
39	40 7/8	1/2	0.1345	141.48	0.1875	166.41	0.2500	188.99
42	43 7/8	1/2	0.1875	176.94	0.2500	200.95	0.3125	228.10
48	49 7/8	1/2	0.1875	201.13	0.2500	228.41	0.3125	259.28



NOTES:

[1]In the nominal diameter range of 14" thru 48", cylinder outside diameters other than those shown are available upon request.

[2]Required cylinder thicknesses for welded steel pipe shown in the accompanying tables are based on the formula:

$$t = \frac{(P)(D)}{2S}$$ (Minimum t shall not be less than 14 ga.)

where: t = Required cylinder thickness, in inches
P = Internal working pressure of pipe, in psi
D = Outside diameter of cylinder, in inches
S = Allowable steel design stress, 16,500 psi.
S is determined by the yield point of the grade of steel being used utilizing a safety factor of 2.

$$S \text{ allowable} = \frac{\text{Yield Point}}{2}$$

For Table I, ASTM A 570 Grade C steel has been used. Yield Point equals 33,000 psi.

[3]Higher yield point steels are readily available and should be considered in preparing practical and economical pipeline designs, especially in the instances of large diameters, or high internal pressures, or both. Information on steels available are shown in Table 2.

[4]Cement-mortar lining thicknesses as shown in the above table are in accordance with the requirements of Federal Specification SS-P-385a. Coal-tar enamel coating thickness is 3/32" in accordance with requirements of AWWA C 203-66.

Allowable tolerances:

Mortar lining thickness	±25%
Coal-tar enamel coating thickness	±1/32"

[5]Shipping weights shown are approximate.

CLASS 250 PSI		CLASS 300 PSI		CLASS 350 PSI		CLASS 400 PSI	
CYLINDER THICKNESS (inches)[2]	SHIPPING WEIGHT (lbs./ft.)[5]	CYLINDER THICKNESS (inches)[2]	SHIPPING WEIGHT (lbs./ft.)[5]	CYLINDER THICKNESS (inches)[2]	SHIPPING WEIGHT (lbs./ft.)[5]	CYLINDER THICKNESS (inches)[2]	SHIPPING WEIGHT (lbs./ft.)[5]
0.0747	9.35	0.0747	9.35	0.0747	9.35	0.0747	9.35
0.0747	14.04	0.0747	14.04	0.0747	14.04	0.1046	16.05
0.0747	18.44	0.1046	21.08	0.1046	21.08	0.1046	21.08
0.1046	26.43	0.1046	26.43	0.1345	29.72	0.1345	29.72
0.1046	31.46	0.1345	35.41	0.1345	35.41	0.1875	42.40
0.1345	44.89	0.1345	44.89	0.1875	53.02	0.1875	53.02
0.1345	50.70	0.1875	59.75	0.1875	59.75	0.2500	70.70
0.1875	66.78	0.1875	66.78	0.2500	79.01	0.2500	79.01
0.1875	88.67	0.2500	100.70	0.2500	100.70	0.2500	100.70
0.1875	90.66	0.2500	105.35	0.2500	105.35	0.3125	120.00
0.2500	119.05	0.2500	119.05	0.3125	135.14	0.3125	135.14
0.2500	133.06	0.3125	151.05	0.3125	151.05	0.3750	169.12
0.2500	147.35	0.3125	167.27	0.3750	187.28	0.3750	187.28
0.3125	183.04	0.3125	183.04	0.3750	204.94	0.4375	220.23
0.3125	198.78	0.3750	222.56	0.4375	239.17	0.5000	263.20
0.3125	214.52	0.3750	240.19	0.4375	258.11	0.5000	284.04
0.3750	255.39	0.4375	274.45	0.5000	302.02	0.5625	360.00
0.3750	290.29	0.5000	343.30	0.5625	402.20	0.6250	460.71

Yield Point and Tensile Strength Comparison for A.S.T.M. A 283, A.S.T.M. A 570 and A.P.I. 5LX

TABLE 2

STEEL SPECIFICATION	GRADE	YIELD POINT (MIN. PSI)	TENSILE STRENGTH (MIN. PSI)
A.S.T.M. A 283 (Plates)	A	24,000	45,000
	B	27,000	50,000
	C	30,000	55,000
	D	33,000	60,000
A.S.T.M. A 570 (Sheets & Coils)	A	25,000	45,000
	B	30,000	49,000
	C	33,000	52,000
	D	40,000	55,000
	E	42,000	58,000
A.P.I. 5LX (Sheets & Coils)	X42	42,000	60,000
	X46	46,000	63,000
	X52	52,000	66,000

ALLOWABLE TRENCH BACKFILL LOADING

TABLE 3 90% COMPACTION[5]

NOMINAL DIAMETER (inches)	CLASS 100 PSI Allowable Pv (psf)	CLASS 100 PSI Allowable h (feet)	CLASS 150 PSI Allowable Pv (psf)	CLASS 150 PSI Allowable h (feet)	CLASS 200 PSI Allowable Pv (psf)	CLASS 200 PSI Allowable h (feet)
39	3267	29.7		*		*
40		*		*		*
42	3201	29.1		*		*
48	2585	23.5	3102	28.2		*

*In Table 3, indicates allowable trench backfill heights in excess of 30 feet.

Note: With 90% compaction, allowable trench backfill heights for all diameters and classes of pipe shown in Table I exceed 30 feet, except as shown in Table 3.

TABLE 4 85% COMPACTION[5]

12	2200	20.0	2200	20.0	2365	21.5
14	2277	20.7	2277	20.7	2343	21.3
16	2024	18.4	2068	18.8	2068	18.8
18	1892	17.2	1936	17.6	1980	18.0
20	2090	19.0	2145	19.5	2156	19.6
21	2024	18.4	2035	18.5	2090	19.0
22	1980	18.0	1980	18.0	2112	19.2
24	1892	17.2	1903	17.3	1980	18.0
26	1837	16.7	1848	16.8	1892	17.2
28	1793	16.3	1793	16.3	1848	16.8
30	1771	16.1	1793	16.3	1793	16.3
32	1760	16.0	1760	16.0	1837	16.7
33	1738	15.8	1760	16.0	1804	16.4
34	1727	15.7	1749	15.9	1793	16.3
36	1727	15.7	1738	15.8	1760	16.0
38	1705	15.5	1738	15.8	1760	16.0
39	1672	15.2	1727	15.7	1760	16.0
40	1727	15.7	1727	15.7	1738	15.8
42	1705	15.5	1738	15.8	1771	16.1
48	1606	14.6	1628	14.8	1694	15.4

*In Table 4, indicates allowable trench backfill heights in excess of 30 feet.

TABLE 5 70% COMPACTION[5]

12	1650	15.0	1650	15.0	1881	17.1
14	1694	15.4	1694	15.4	1870	17.0
16	1276	11.6	1364	12.4	1364	12.4
18	1012	9.2	1056	9.6	1166	10.6
20	1430	13.0	1485	13.5	1529	13.9
21	1287	11.7	1331	12.1	1408	12.8
22	1210	11.0	1210	11.0	1441	13.1
24	1012	9.2	1045	9.5	1177	10.7
26	880	8.0	913	8.3	1023	9.3
28	803	7.3	825	7.5	902	8.2
30	737	6.7	814	7.4	814	7.4
32	704	6.4	770	7.0	858	7.8
33	671	6.1	726	6.6	825	7.5
34	660	6.0	704	6.4	803	7.3
36	627	5.7	660	6.0	759	6.9
38	616	5.6	627	5.7	693	6.3
39	605	5.5	627	5.7	682	6.2
40	616	5.6	616	5.6	660	6.0
42	594	5.4	627	5.7	715	6.5
48	561	5.1	594	5.4	638	5.8

*In Table 5, indicates allowable trench backfill heights in excess of 20 feet.

[1]Values of Pv and h shown are calculated with the maximum allowable deflection of the installed pipe being 4% of the original undeflected diameter.

[2]Trench loading capabilities based on "Ring Deflection of Buried Pipes" by Reynold K. Watkins and Albert B. Smith.

Soil weight used was 110 lbs./cu. ft.

[3]Allowable fill heights for soils having unit weights other than 110 lbs./cu. ft. may be calculated by dividing the allowable Pv value shown for a given size and class of pipe by the design soil weight.

CLASS 250 PSI Allowable Pv (psf)	CLASS 250 PSI Allowable h (feet)	CLASS 300 PSI Allowable Pv (psf)	CLASS 300 PSI Allowable h (feet)	CLASS 350 PSI Allowable Pv (psf)	CLASS 350 PSI Allowable h (feet)	CLASS 400 PSI Allowable Pv (psf)	CLASS 400 PSI Allowable h (feet)
2365	21.5	2640	24.0	2640	24.0		
2530	23.0	2530	23.0	3080	28.0	3080	28.0
2145	19.5	2420	22.0	2420	22.0		
2145	19.5	2145	19.5	2640	24.0	2640	24.0
2310	21.0	2717	24.7	2717	24.7	2717	24.7
2200	20.0	2497	22.7	2497	22.7	3300	30.0
2112	19.2	2343	21.3	2343	21.3	3036	27.6
2145	19.5	2145	19.5	2629	23.9	2629	23.9
2024	18.4	2024	18.4	2332	21.2	2849	25.9
1936	17.6	2178	19.8	2178	19.8	2541	23.1
1870	17.0	2046	18.6	2299	20.9	2299	20.9
1837	16.7	1947	17.7	2156	19.6	2475	22.5
1914	17.4	1914	17.4	2101	19.1	2365	21.5
1892	17.2	1892	17.2	2046	18.6	2299	20.9
1848	16.8	1947	17.7	2189	19.9	2475	22.5
1793	16.3	1914	17.4	2068	18.8	2310	21.0
1782	16.2	1892	17.2	2035	18.5	2255	20.5
1782	16.2	1870	17.0	1991	18.1	2211	20.1
1815	16.5	1925	17.5	2090	19.0	2332	21.2
1771	16.1	1914	17.4	2046	18.6	2244	20.4
1881	17.1						
2090	19.0	2090	19.0				
1496	13.6	1980	18.0	1980	18.0	2200	20.0
1496	13.6	1496	13.6				
1782	16.2						
1584	14.4	2057	18.7	2057	18.7		
1441	13.1	1848	16.8	1848	16.8		
1441	13.1	1441	13.1	1991	18.1	1991	18.1
1265	11.5	1265	11.5	1650	15.0		
1078	9.8	1408	12.8	1408	12.8	1914	17.4
968	8.8	1210	11.0	1584	14.4	1584	14.4
858	7.8	1067	9.7	1386	12.6	1870	17.0
1012	9.2	1012	9.2	1298	11.8	1694	15.4
968	8.8	968	8.8	1210	11.0	1584	14.4
869	7.9	1089	9.9	1419	12.9	1859	16.9
814	7.4	990	9.0	1254	11.4	1606	14.6
792	7.2	946	8.6	1199	10.9	1518	13.8
770	7.0	891	8.1	1144	10.4	1441	13.1
847	7.7	1023	9.3	1298	11.8	1650	15.0
715	6.5	1001	9.1	1221	11.1	1507	13.7

[4]Allowable Pv values shown represent the maximum vertical in place loading, either dead or a combined dead and live load, to which the particular diameter and class of pipe should be subjected for the degree of compaction provided.

[5]Percent compaction shown for each table is the percentage of standard density as determined in accordance with the requirements of either ASTM D 698 or AASHO T 99.

[6]Allowable trench backfill heights for diameters and wall thicknesses not shown are available upon request.

BPT STD 12-68
Edition Nov. 1968

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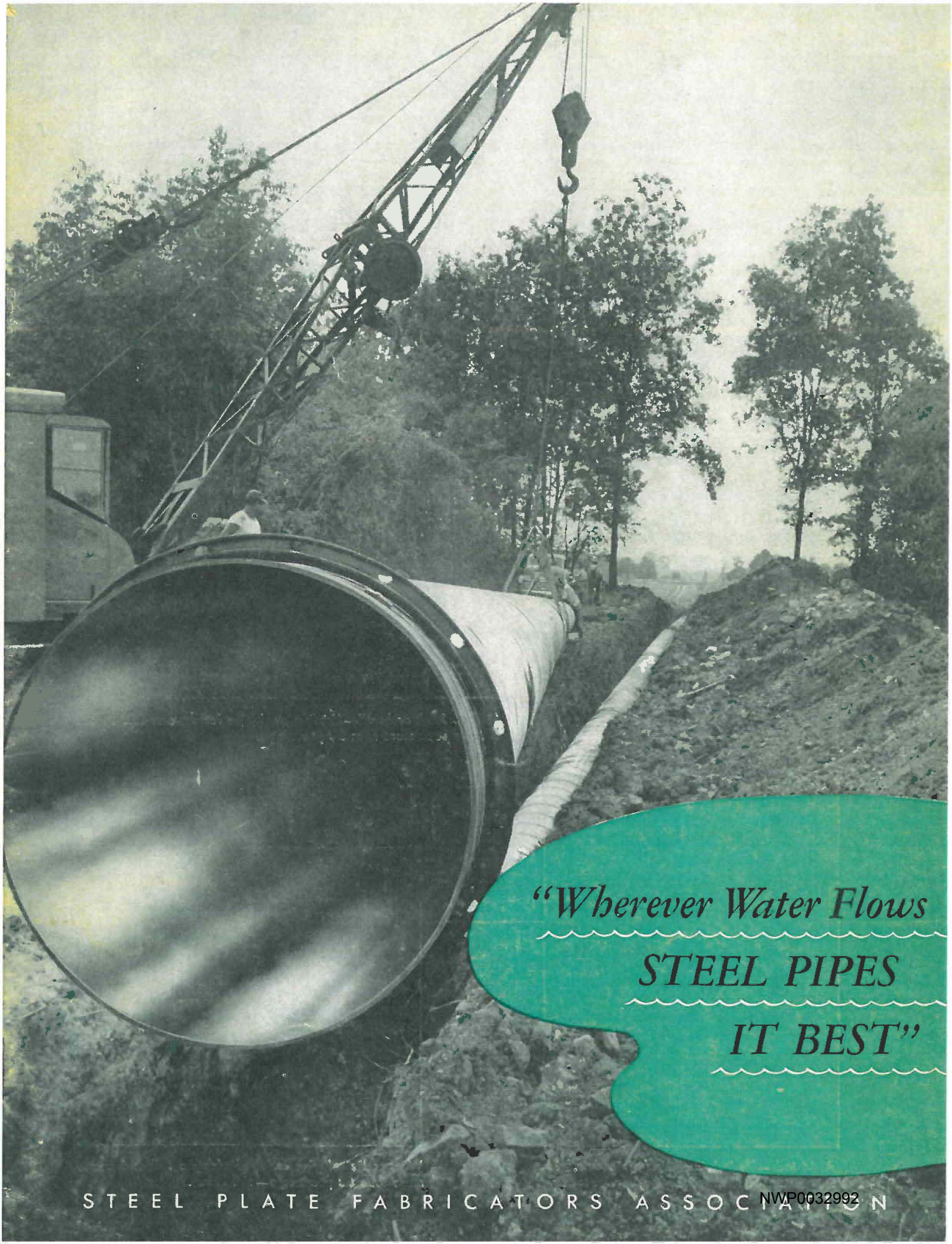
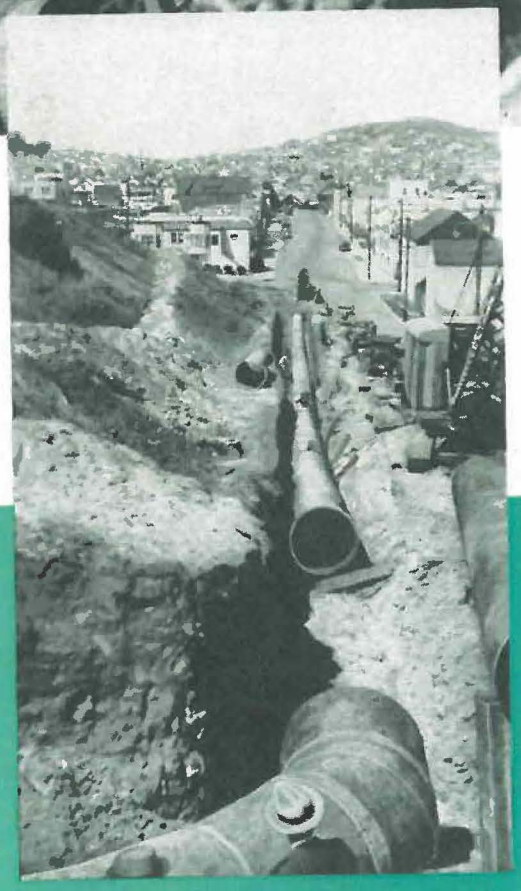


STEEL PLATE FABRICATORS ASSOCIATION

NWP0032992

"Pike's Peak or bust"—Hauling steel pipe for a water line up the famous peak more than 30 years ago.



A 44 inch—3/16 inch thick steel water line laid 72 years ago in San Francisco, in service today.

Wrapped steel pipe installed along a railroad trestle more than 50 years ago—still in use.

NWP0032993

HISTORY OF STEEL PIPE

SEARCH FOR DURABILITY

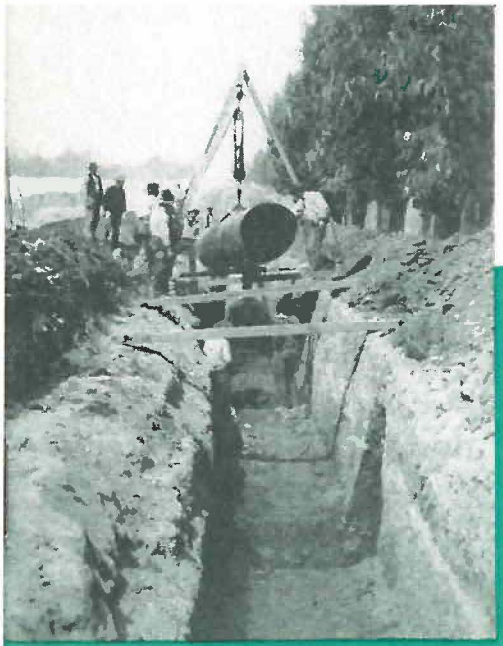
Thousands of years ago men first learned the secret of conducting water through crude pipes. Long before the birth of Christ, the Chinese transported water through bamboo; a Babylonian king who reigned 4500 years ago had a bathroom with tile drain pipes; a municipal reservoir served Carthage about 800 B.C. and there is much evidence of the fine water supply systems of the Romans.

But as cities grew larger, and homes were built closer to each other, the problem of adequate water supply became acute and intensified efforts to construct more durable piping systems. This was especially so in the early days of this country when every means of enticing settlers was used to build up the new cities. Iron, used in Europe for pipe as early as 1685, was scarce in the United States and much more valuable as material for muskets. So our first pipe lines—in such cities as New York, Boston and Philadelphia—were constructed of bored logs as early as 1752.

American ingenuity was even then working hard to solve the problem of a pipe with real durability, and by 1825 a method of manufacturing pipe from long strips of hot metal was devised. This might be said to be the first basis for making strong pipe economically. Pipe mills, making wrought iron pipe, sprang up in several cities, and with the development of the Bessemer process in 1855 and the open hearth process in 1861, steel, the strongest and most versatile refinement of iron, became available for water pipe. The long years of steady development to combine the vitally necessary durability with strength had finally ended, and steel pipe was ready to play the truly dramatic role it has filled in the development of the country.

LONG SERVICE RECORDS

Available records disclose installations of steel pipe still in use which were laid as early as 1863—92 years ago—in a five mile line for supplying water to San Francisco. Beginning in 1870 with other riveted lines, and in 1887 with the installation of the first welded steel pipe, records show scores of examples of steel pipe, still in use and giving excellent service, which was laid more than 50 years ago. These records of long service are especially significant of the basic durability of steel when it is remembered that a majority of the pipe was laid before the advent of modern protective lining coatings, and wrappings. Of particular interest is the considerable improvement in



A steel water pipe line being installed in the far west in 1885. After 70 years, this line is still in service.

Preparing to install 84 inch coal tar enameled steel pipe for the city of Baltimore in 1915. This line is still in service.

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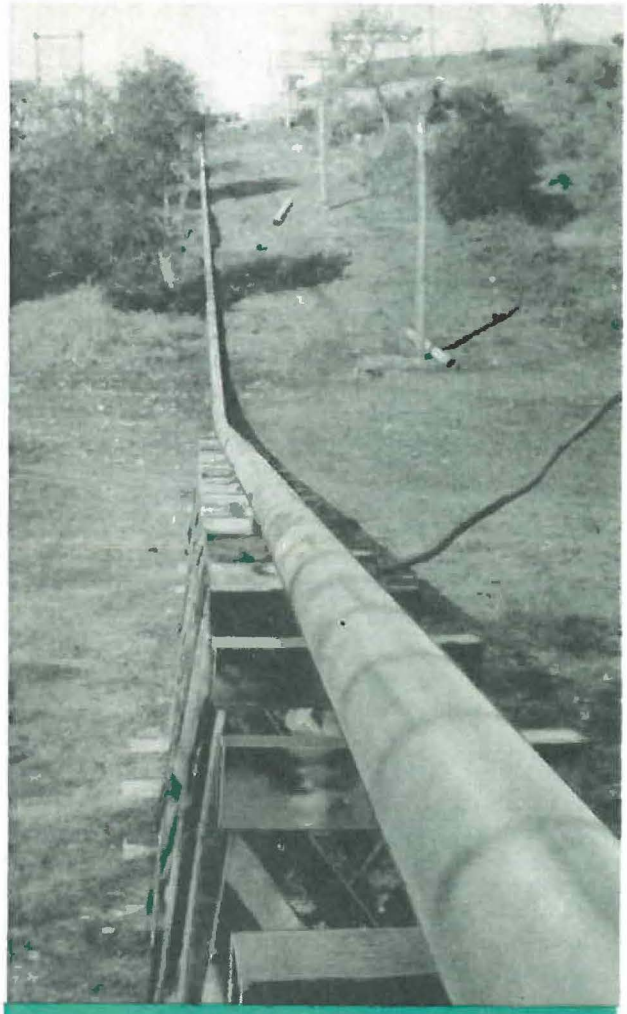


In 1858 steel sheets, shipped to San Francisco for building needs, were rolled into pipe 11 inches to 22 inches in diameter and installed in Calaveras County, Calif. The pipe has been in use practically continuously since that time. Service life to date—97 years.

the quality of steel which has taken place in the past twenty-five years. Modern steel water pipe mains, properly lined, coated, wrapped and coupled, can be conservatively estimated, therefore, to have a useful life of at least 100 years.

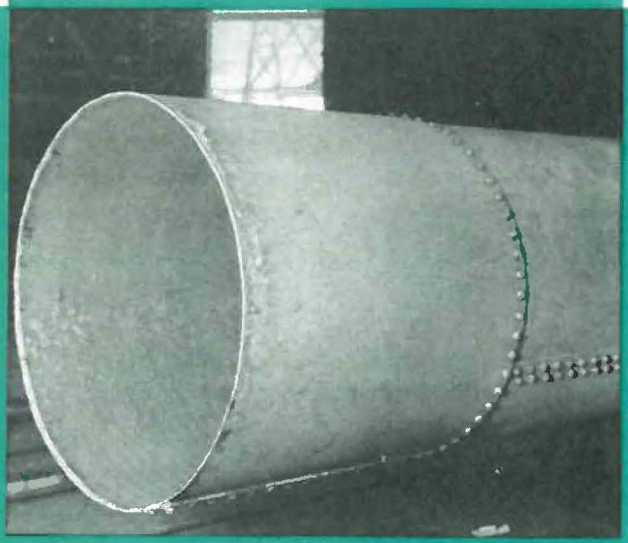
USE TODAY

More than 200 of the major cities of the United States now have a total of more than 100 million feet* of steel water pipe in use. This figure could be greatly increased by the inclusion of pipe in use by hundreds of smaller municipalities, as well as the various district, state and national public projects which call for the use of water carrying pipe. Foreign cities and governments, too, have been users of steel pipe for many years.

LONG TIME USERS

The following list of installations illustrates the longevity of serviceable use as a major characteristic of steel water pipe:

*Bureau of Commerce
American City Magazine



Steel water pipe, originally installed at Portland, Oregon, in 1895, taken out of service in 1953. After reconditioning by cleaning and coating the pipe was in almost 100 percent original condition and relaying was authorized by the Corps of Engineers, U. S. Army.

City of San Francisco—44" riveted steel water line as installed in 1885. The line is still in service.

NWP0032995

PARTIAL LIST OF EXISTING

STEEL PIPE INSTALLATIONS

WITH 50 OR MORE YEARS OF SERVICE

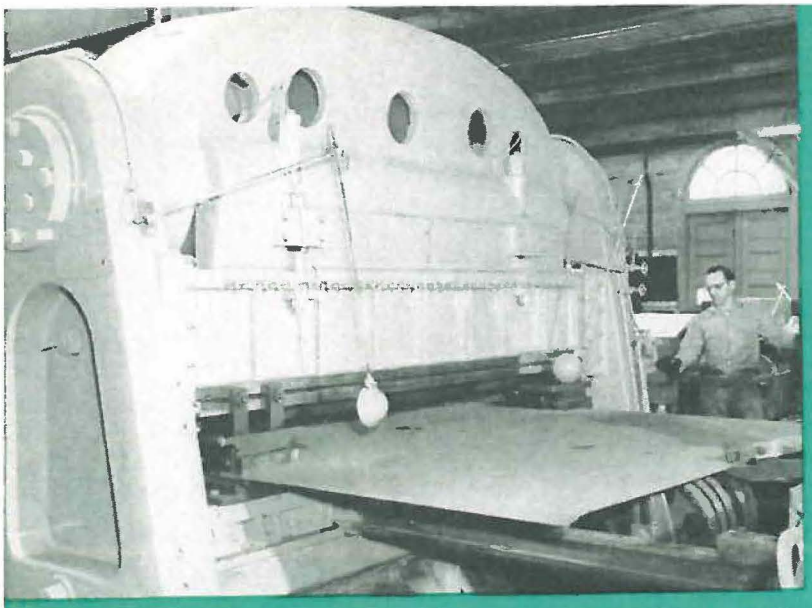
LOCATION	INSTALLED	SIZE	YEARS OF SERVICE
New York, N.Y.	1860	120″	95
San Francisco, Calif.	1863	30″	92
Magalia, Calif.	1870	30″	85
Pittsburgh, Pa.	1874	50″	81
Carson City, Nevada	1874	12″	81
Los Angeles, Calif.	1880	44″	75
Lawrence, Mass.	1881	77″	74
Pasadena, Calif.	1888-89	22″	67
Detroit, Mich.	1890	62″	65
Newark, N. J.	1891	36″ & 48″	64
Rochester, N. Y.	1893	36″	62
Syracuse, N. Y.	1893	54″	62
Portland, Oregon	1894	42″ & 33″	61
Vancouver, B.C.	1895	22″ & 16″	60
New Westminster, B.C.	1896	14″	59
New York, N. Y.	1896	72″	59
New Bedford, Mass.	1896	48″	59
Minneapolis, Minn.	1897	50″	58
Jersey City, N. J.	1897	48″	58
Ogden, Utah	1897	72″	58
Paterson, N. J.	1897	42″	58
Duluth, Minn.	1898	42″	57
Albany, N. Y.	1898	48″	57
Seattle, Wash.	1899	42″	56
Kansas City, Mo.	1903	36″	52

"Wherever Water Flows

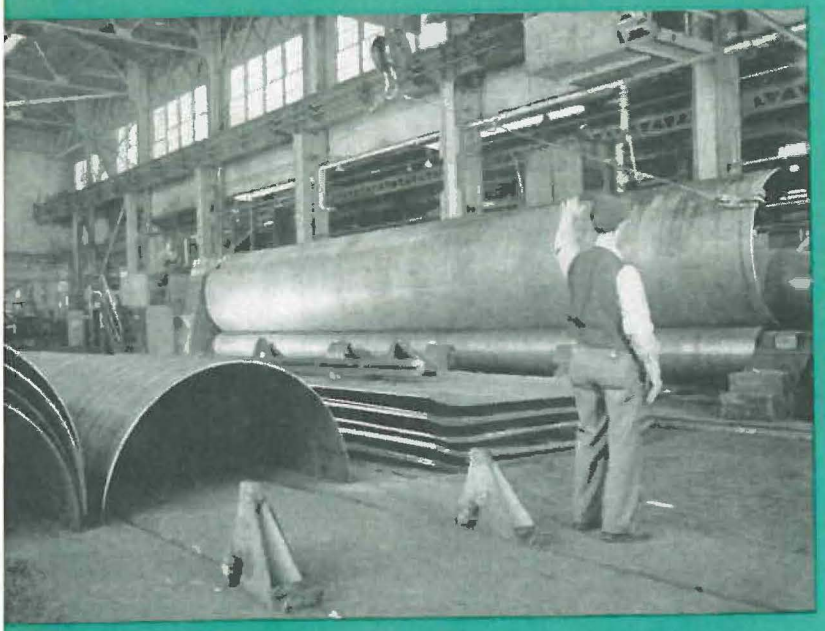
STEEL PIPES

IT BEST"

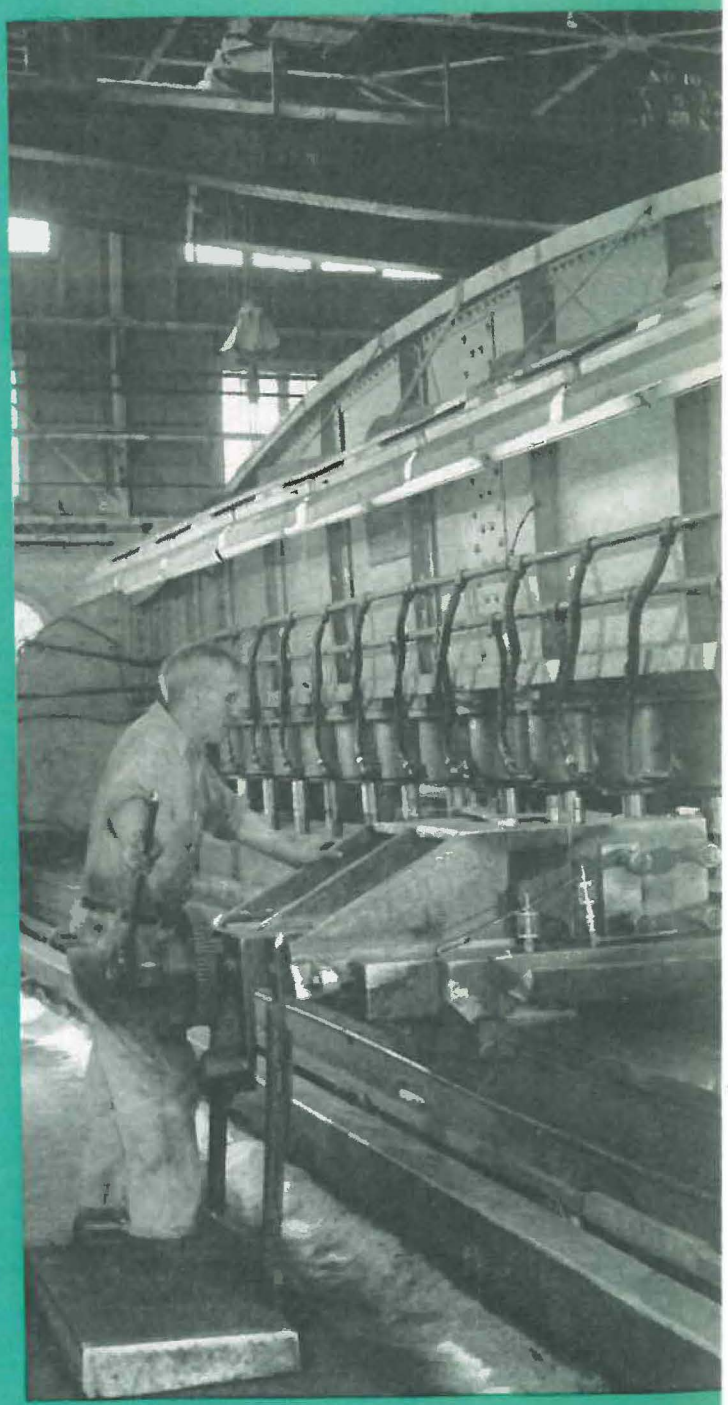
NWP0032996



Crimping the edges of a steel plate preparatory to rolling into cylinders.



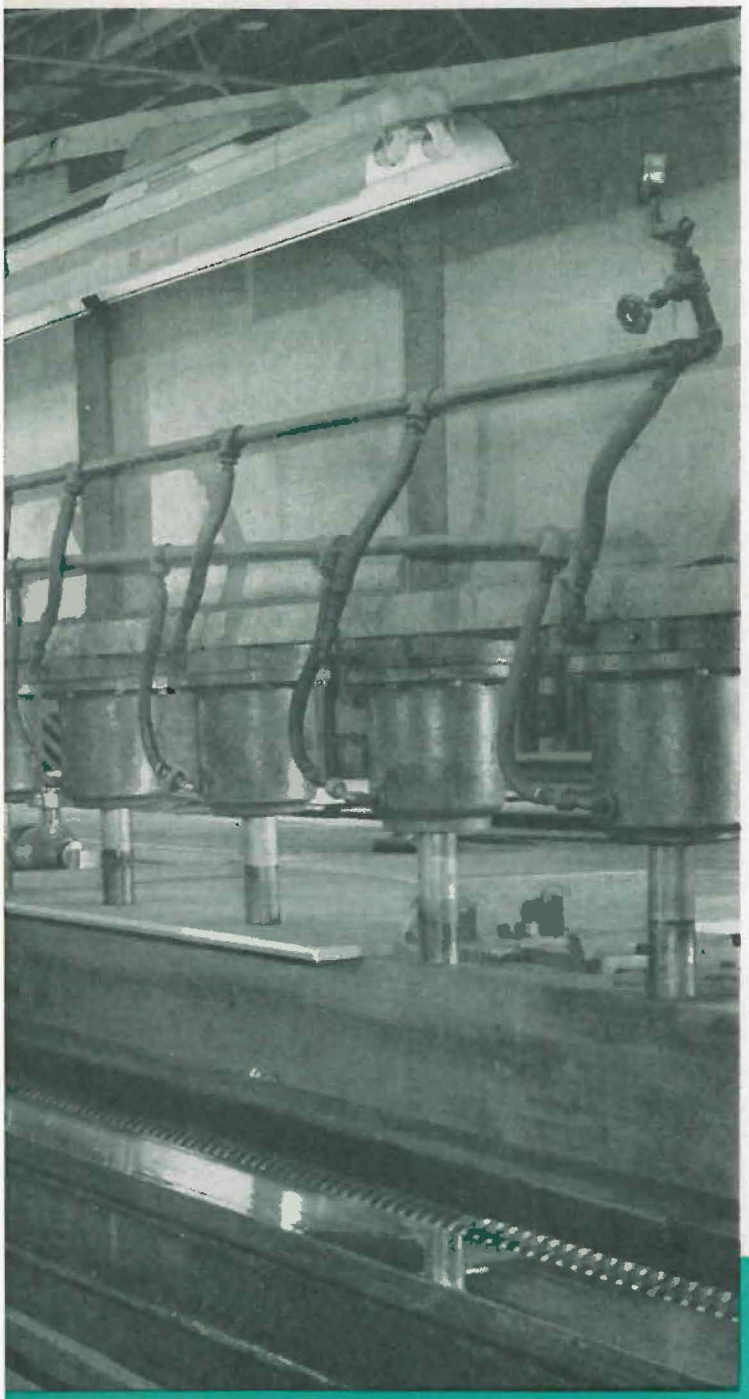
Forming of half cylinders on 40 foot roll. Note crimped plates in foreground ready for rolling, as well as completed half cylinders.



Forming a 32 foot steel plate into a cylinder in a new automatic plate roll machine.

NWP0032997

HOW STEEL PIPE IS MANUFACTURED



Automatic beveling machine preparing edges of steel plate for electric arc welding.

As we have seen, steel pipe, when properly designed and installed, has an extremely long useful life. Since it has in addition so many advantages over other carriers of water, there must be definite reasons for its superior characteristics. A review of some of the basic facts about the manufacture of steel into pipe points out some of these reasons:

SPECIFIC MANUFACTURING PROCESSES

There are several methods of manufacture of large dimension steel pipe for use in water conveyance. Each permits fabrication in specific diameters. Available lengths vary from 30 to 50 feet. Wall thicknesses can be furnished to meet any operating conditions. But all of them have one attribute in common . . . the great strength of the finished pipe.

1. *Fusion Welded* (electric-arc welded)

Longitudinal Weld: This type of pipe is manufactured by preparing or trimming the edges of steel plates to size, forming the plates into cylindrical shapes, and welding them together by the automatic submerged-arc process. Thus, a welded joint strength equal to that of the plate itself is obtained. This pipe can be shop fabricated in sizes limited only by the carrying capacity of a common carrier. Sizes up to 12 feet in diameter come within this category. Larger sizes can be erected in the field, after shipment in knocked down form from the fabricating shop.

Spiral Weld: Long strips of flat rolled steel are trimmed and straightened. Then an automatic machine prepares the edges for welding and spirally winds the steel into a continuous tube of the required diameter. An automatic submerged-melt type electric

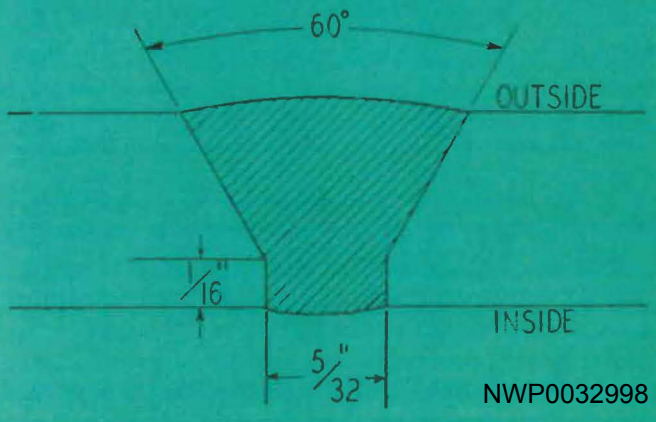


Diagram of typical weld for field girth seams 60 degree single V with 5/32" root opening.

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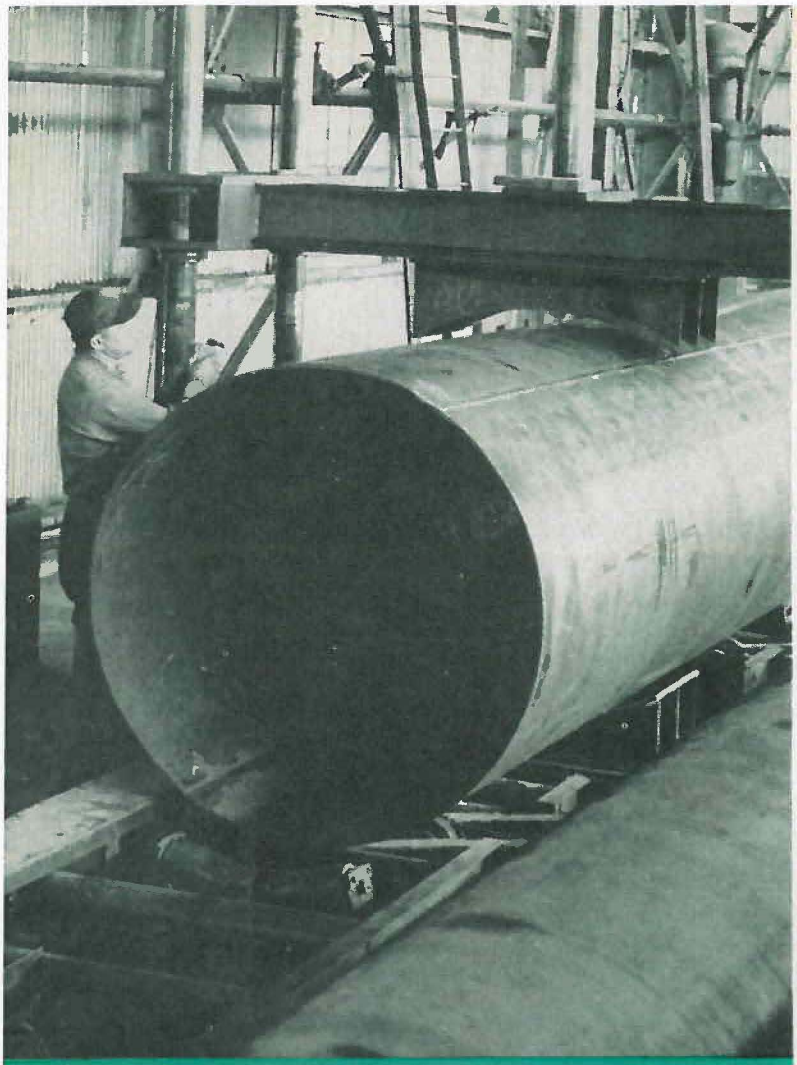


Close up view of press for insuring perfect roundness of pipe ends.

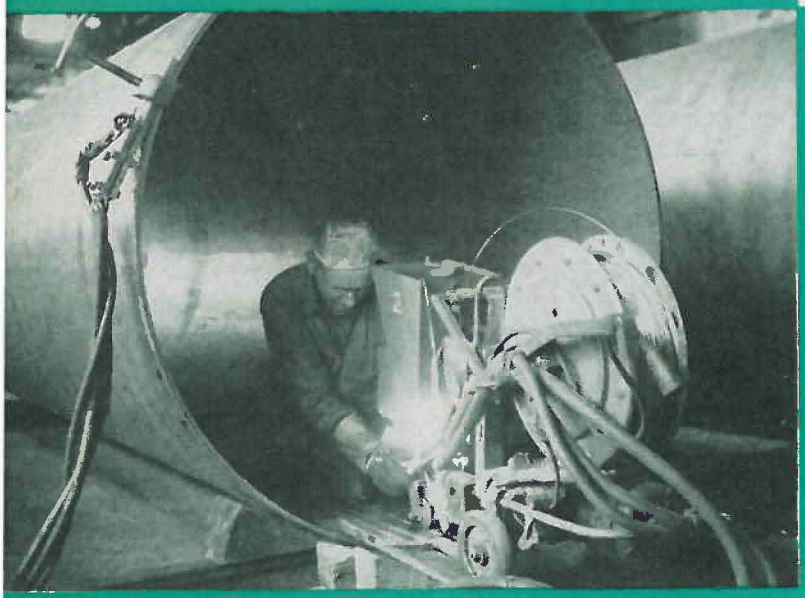
arc butt-welds the seam as it leaves the forming machine. Sizes range from 4 inches to 36 inches in diameter.

2. *Resistance Welded:* Long sheets in coils are formed into cylindrical shape and fused together progressively by means of pressure and heat generated by high amperage electric current. This pipe is made in sizes of ⅛ inch to 16 inches in diameter.

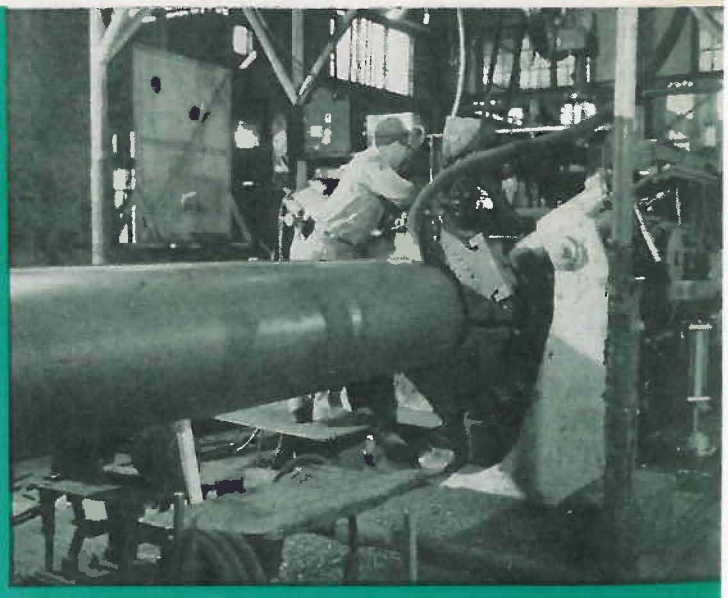
3. *Cold Worked Pipe:* This type of pipe is fabricated by the electric-arc welding method . . . and then is "cold worked" to give it added strength. The pipe is made slightly under the required finished diameter and is then expanded by hydraulic pressure. This cold-working process materially increases the yield strength,* thus permitting the use of thinner wall pipe at a given pressure (and saving approximately 25% on weight). It fully tests the strength of the welded seam at the yield strength of the parent plate, and its expansion into a true cylinder gives uniform roundness, size and straightness in the pipe. Diameters for cold-worked pipe range from 6⅝ to 40 inches.

STANDARDS OF MANUFACTURE AND TESTING

To meet the exacting requirements of those who wish the best type of pipe for transportation of water, fabricators of steel pipe have set the highest standard for its manufacture. Especially significant are the modern testing processes. *Every section of steel pipe is*



Automatic welding machine being set up for internal welding of inside seam on ½" thick plate.



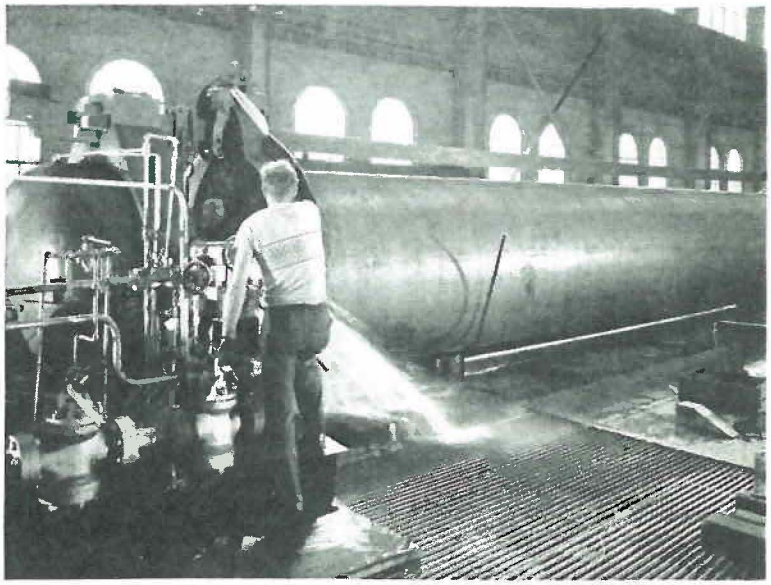
Automatic electric-arc welding machine for exterior welding. Produces welds as strong as the parent metal.

NWP0032999

hydrostatically tested in the shop. Water is turned into the pipe and gradually brought up to the testing pressure of two times the working pressure, or according to specifications. Although careful fabrication insures exact conformity to desired specifications, in addition, steel pipe is carefully inspected to insure uniformity of roundness, correct alignment and conformation of pipe ends to specification tolerances.

Fabricators, too, take the greatest precautions to make certain that steel pipe is absolutely smooth and free of any obstructions that might hinder water flow. For most pipe over six inches in diameter, specially-designed machines clean both interior and exterior, preparatory to application of the final protective coatings which provide a smooth flow surface and add many years to the life of a steel pipe installation.

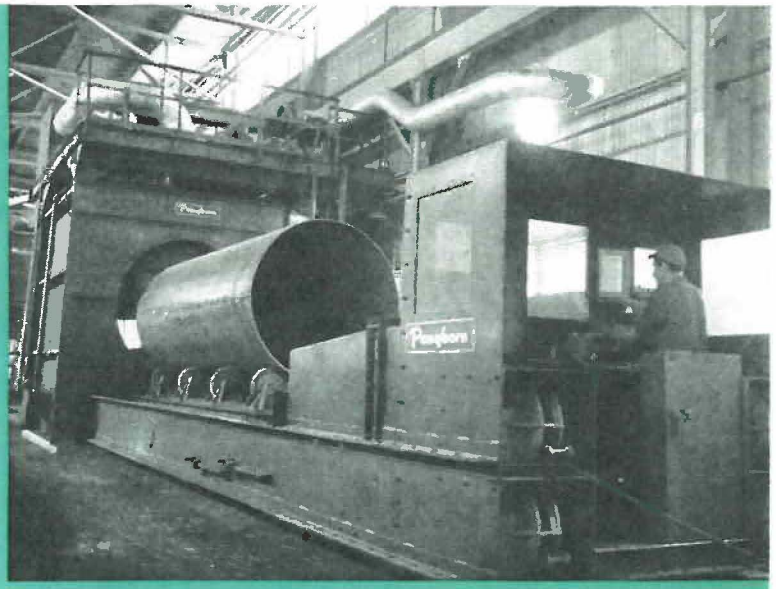
*The stress, measured in pounds per square inch, required to cause steel to deform permanently.



Completing the important hydrostatic test. Each section is placed in this hydrostatic testing machine, where it is subjected to internal water pressure much higher than the actual working pressure of the finished pipe line.

"Wherever Water Flows
STEEL PIPES
IT BEST"

A long section of 36" OD spiral welded pipe emerging from the pipe machine, which forms and welds pipe in a continuous operation.



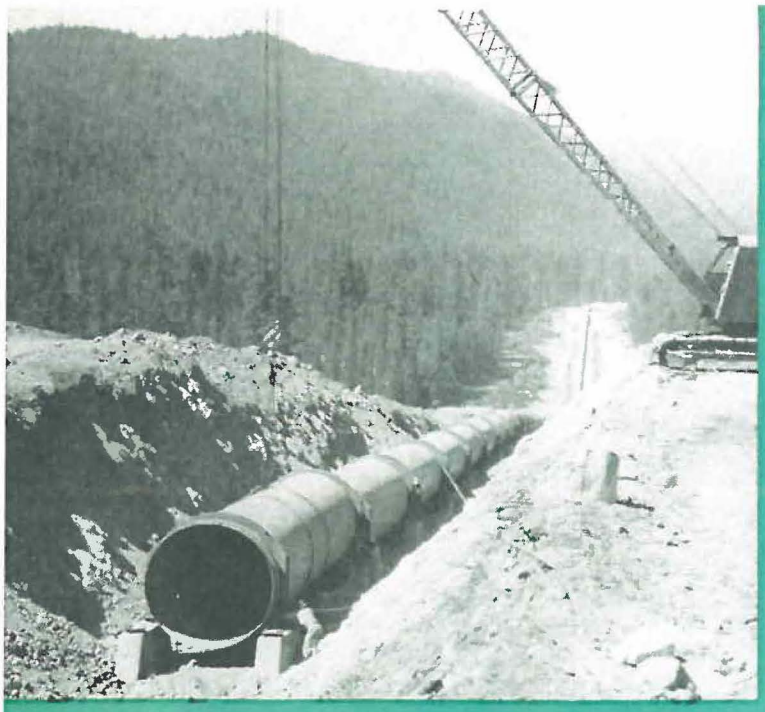
Pipe about to enter special grit blasting machine for cleaning interior and exterior of pipe simultaneously. Machine will handle pipe up to 40' long and diameters to 84".

NWP0033000

Laying large 72" diameter steel water pipe in city streets—note clean ditching and lack of traffic interference.

Field welding of 40 foot sections, large diameter steel water pipe. Note ease of handling with one sling.

NWP0033001



Steel pipe being laid under difficult terrain conditions.

Bouquet Canyon Aqueduct, City of Los Angeles. Coal tar enamel applied on interior by hand daubing. Entire line above ground.

ADVANTAGES OF STEEL PIPE

CHOOSING THE MATERIAL

When we say that steel water pipe has "advantages," we mean, of course, that it has attributes which make it a better carrier of water than other types of pipe. Modern conditions, with their mounting demands on materials as a result of stresses, strains and emergency conditions to which they are subjected, make it essential for officials, engineers and contractors charged with the responsibility of designing, building, and maintaining water lines to select the best material. And the material selected should qualify as "best" in *every* way.

Comparison with other commonly used materials reveals that steel water pipe *does* qualify as the best in every essential respect for use in your water system.

ESSENTIAL REQUIREMENTS

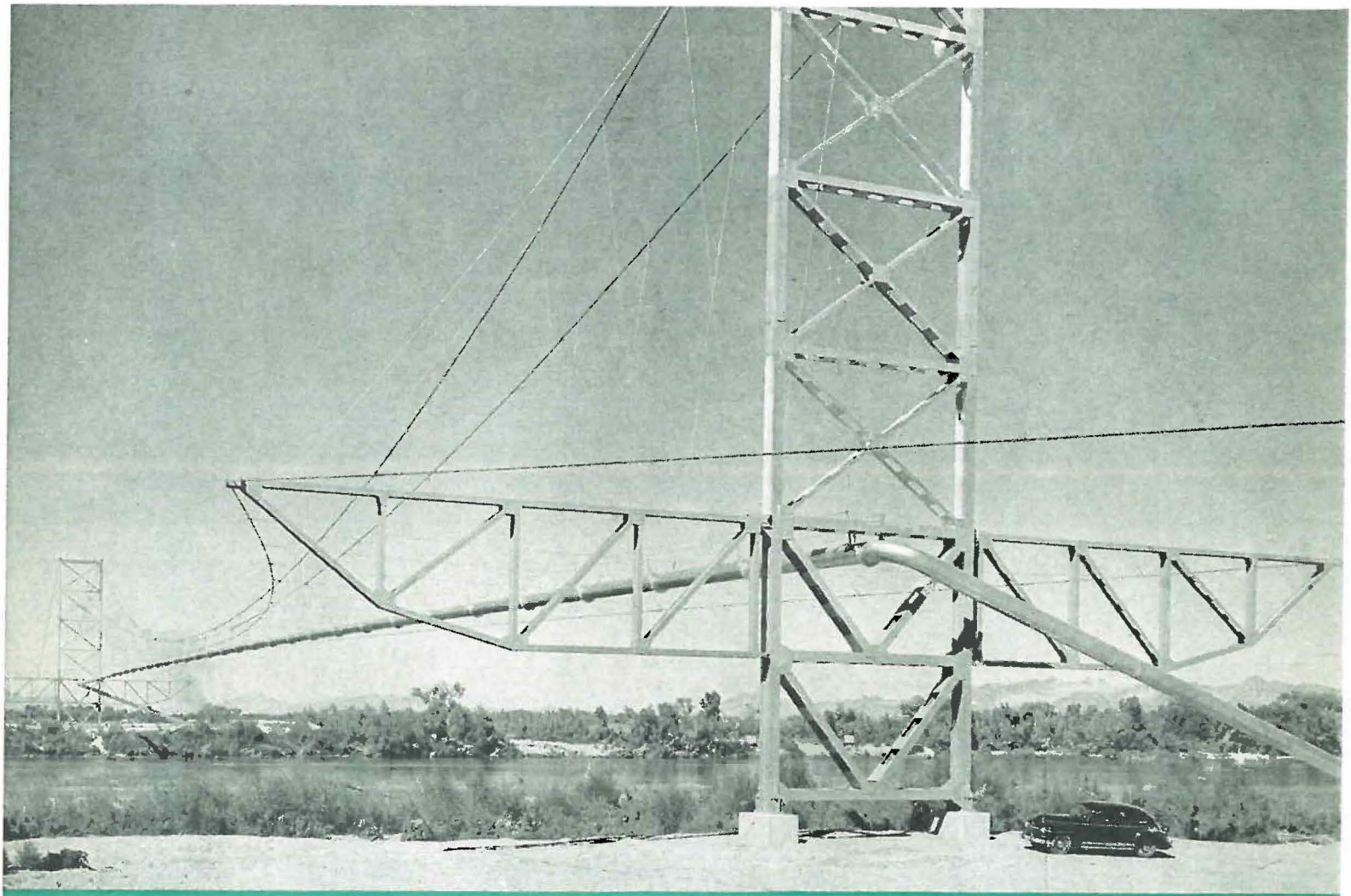
The essential requirements which material for a water pipe line must meet are relatively simple. They can be listed as:

1. Outstanding strength
2. Extreme durability and long life
3. Economy of installation and maintenance
4. High carrying capacity
5. Ductility and adaptability
6. Great reliability and resiliency
7. "Bottle-tight" joints

Steel water pipe answers each of these basic requirements better than any other material now used for water lines. Here is why:

1. An advantage of steel pipe over other materials is its great tensile strength. It stands alone in offering the greatest strength in proportion to wall thickness of any commercial piping material available for use in water lines.
There is no substitute for strength.

NWP0033002



1040 foot Colorado River crossing at Blythe, Calif. Second longest of 4 river crossings of this type. An excellent example of beam strength and flexibility of steel pipe.

2. When it comes to durability and long life, steel pipe makes a superior showing among all types of water-carrying materials. Available records show scores of instances where steel pipe has been in service for over 50 years . . . and is still doing a commendable job. Many others have been in use for much longer periods. With the great advances that have been made during the last few decades in the fabrication of steel and perfection of coatings, the useful life of steel pipe can now be conservatively estimated at 100 years or longer.

3. Steel pipe usually costs no more—and frequently costs less—to buy and install, and an all important advantage is the economy of maintenance which characterizes a steel water pipe line.

4. Every water line system needs the maximum possible carrying capacity. Population increases can make a line obsolete quickly unless it can be depended upon not only to have the greatest possible capacity when installed, but to maintain that capacity in use. Properly lined and coated steel water pipe is impervious to corrosion and incrustation. It can be relied on to maintain its carrying capacity. An additional advantage is the wide margin of safety engineered into steel pipe. As a result, it is possible, in the event of greater future demands, to increase the carrying capacity by boosting the pressure, and yet to stay well within safety limits.

5. Of almost equal importance, the extreme ductility of steel water pipe is a unique advantage as com-

NWP0033003

pared with other materials. It is this unusual characteristic—available *only* in steel water pipe—which makes possible its wide use in terrain situations where other materials either cannot be used, or can be installed only with difficulty or at additional expense.

6. Reliability is perhaps not so much an advantage as it is a definite necessity in any water line. Once installed, engineers can depend upon steel pipe to do the job for which it was designed. This reliability extends not only to constant carrying capacity, but to its ability to withstand any number of unexpected or emergency conditions. It means resistance to water hammer and to washouts. It includes the *resilience* to "give" under soil movement and immunity to surface vibrations.

7. A requirement of utmost importance which steel pipe fills completely is the necessity for "bottle-tight" joints. No water line can operate successfully and economically without leak-proof joints. Wastage of water can be, as every engineer knows, the most expensive fault of any water system. Here steel pipe excels. Joints in steel pipe, whether welded or mechanical, are completely water tight—and will stay that way for the life of the line.

Finally, steel water pipe lines bring you a bonus advantage in the form of improved public relations . . . an advantage not to be taken lightly. The people of your community will appreciate the better service at lower cost which they receive.

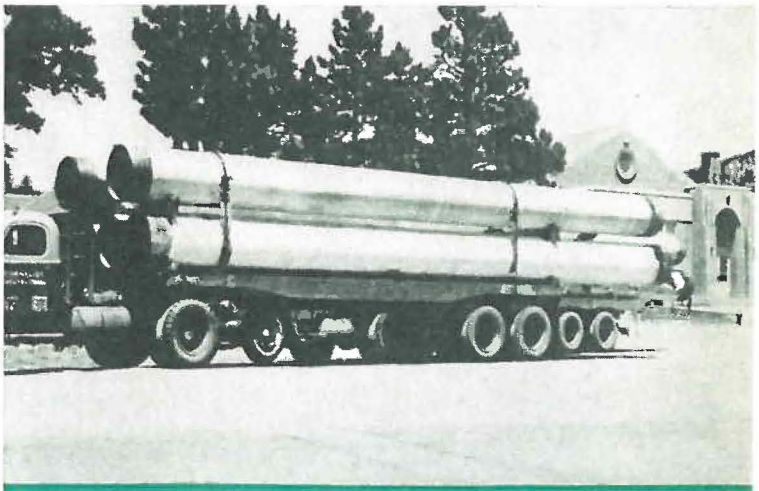
STEEL . . . THE IDEAL MATERIAL

No other material offers all of the requisites for a good conduit—strength, long life, economy, permanent high carrying capacity, ductility, reliability, and "bottle-tight" joints.

Perhaps the major consideration in the selection of pipe material for conveyance of water should be strength without the handicap of rigidity. In this respect, steel surpasses all other materials because it has maximum strength with maximum ductility. The tensile strength* of steel normally used for water pipe is 50,000 pounds per square inch and may go higher if necessary. Because of this great strength and ductility, steel pipe resists suddenly applied emergency pressure, surge, water hammer, earthquakes, traffic vibrations, settlement, cave-ins, washouts, floods, temperature changes, blastings, bombings, and other similar conditions which so easily destroy other types of pipe. This means that, unlike rigid materials, steel not only has great strength but also has the ability and toughness to withstand great shock without shattering.

*Tensile strength is the strength, measured in pounds per square inch, required to pull apart a one-inch steel bar lengthwise.

Added to these major advantages of steel pipe are its many other complementary points of superiority. These include a wide selection of sizes, wall thicknesses and lengths which give you a pipe "custom tailored" for a particular job. Precision fabrication in conformity with A.W.W.A. specifications, and careful testing, provide greater assurance of a satisfactory line. And its longer lengths, combined with considerably less weight than other materials, keep transportation and installation costs at a minimum.



Truck load of coated and wrapped 30" diameter steel pipe, showing method of securing for transport so as to prevent damage.

RESULTS TELL THE STORY

Whatever your basic interest, steel pipe will give you superior results:

1. *For the owner*, its nonporous structure and its leak-proof joints mean that profits won't seep away due to leakage. Rates won't need increasing to help pay for water wastage. Because of steel's ability to stand shock and vibration, costly damage claims resulting from sudden pipe failures will be eliminated. These factors will improve public relations and customer goodwill—with no increase in cost of installation.

NWP0033004

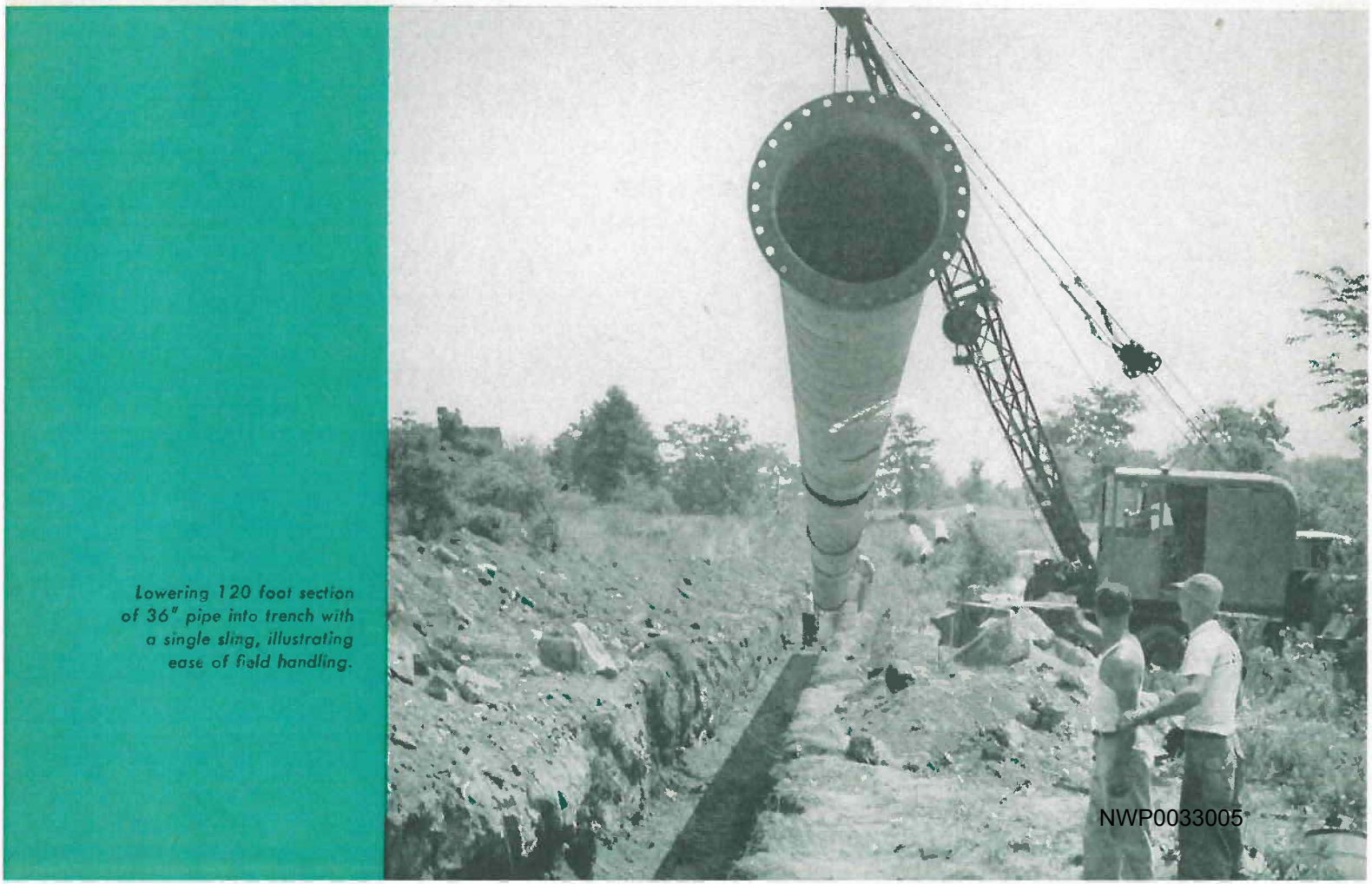
2. *For the design engineer*, the many different diameters and thicknesses available minimize design problems. The fact that steel pipe will withstand such a wide range of pressures again reduces design problems. The factor of safety for steel pipe is usually three or more against bursting, whereas with pipe of rigid material it runs far less, sometimes as little as 1½. This means that a steel line designed for a specific rate of flow can—should it become necessary—deliver much more water by simply increasing the pressure, yet still maintaining a reasonable safety factor. And because each length of steel pipe is thoroughly tested for strength, the engineer can be sure he will get what he pays for.

3. *For the construction engineer*, the longer lengths available in steel water pipe are especially important because they mean fewer field joints. For example, 40 foot lengths of 48″ steel pipe, fabricated to withstand over 200 psi, require only about 132 joints per mile as compared to 300 or more joints required by pipe made in 16 foot lengths. In addition, the 40 foot length of steel pipe weighs approximately 7,000 pounds, whereas a 16 foot length of the same pipe in concrete weighs about 15,000 pounds—and will withstand only 180 psi. This means steel not only requires fewer field joints, but permits using lighter field equipment to lay the line—and a good chance of saving thousands of dollars in installation costs!

4. *For the operating engineer*, steel pipe's leak-proof and shatter-proof characteristics mean fewer operating troubles. It is impossible to have sudden and complete failure of a properly designed steel pipe line thus eliminating costly emergency calls to repair "breaks," flooded sub-surface structures, and cave-ins.

5. *For the "average citizen,"* a steel pipe water line means no streets washed out—no interruption of service—lower water rates, and a saving in his tax bill. And his investment is doubly protected because it is possible to so design the line as to provide for future increased requirements as well as present.

Thus we have in steel pipe as a result of both its basic characteristics, the expertness of manufacturing processes and the exhaustive tests to which it is submitted, the ideal material for the conveyance of water in any size pipe.



Lowering 120 foot section of 36″ pipe into trench with a single sling, illustrating ease of field handling.

DUCTILITY AND ADAPTABILITY

One of the primary requirements to be considered in selecting the type of pipe for water systems is its ductility, and its adaptability of use.

Here steel offers one of its major advantages over other materials. Both in ductility and in adaptability of use, steel pipe completely outclasses other types.

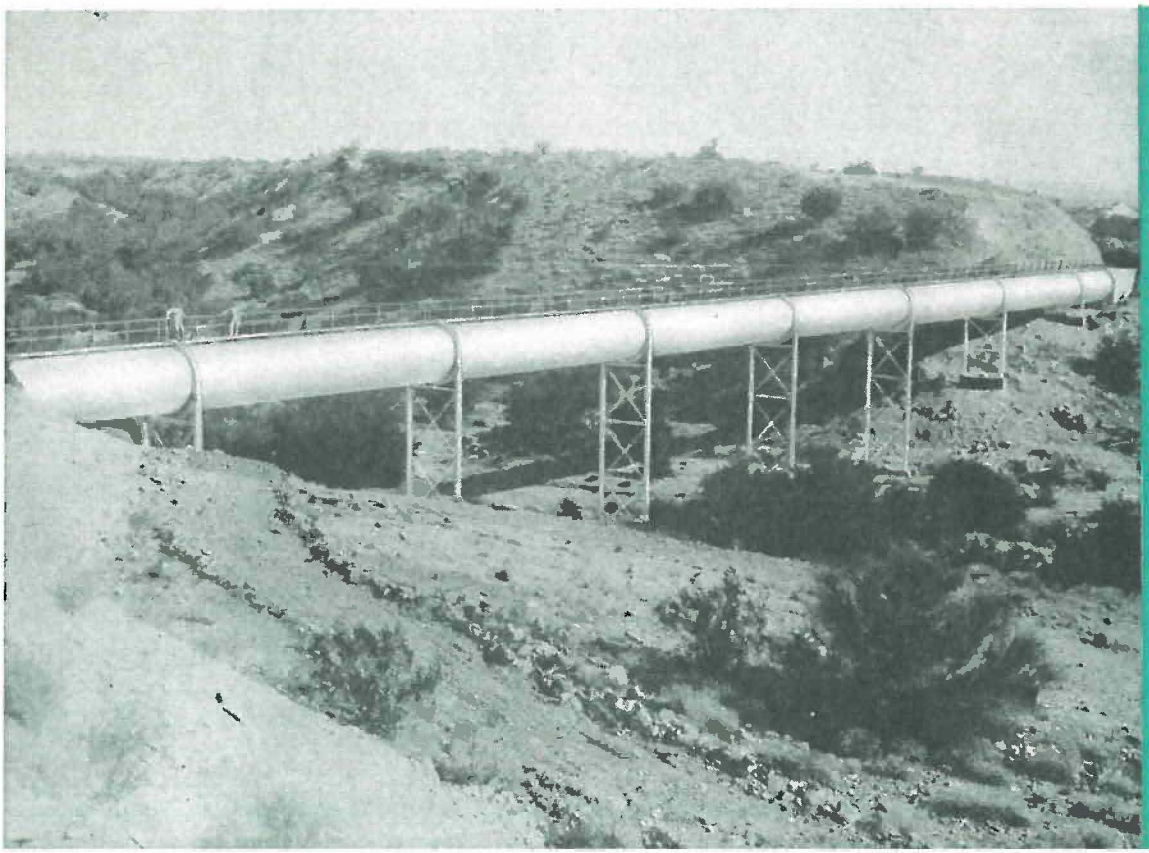
DUCTILITY

The basic characteristics of steel pipe manufactured from ductile, mild steel, eliminate the probability of the structural brittleness which is a characteristic of many other materials. This fact is borne out by engineering statistics, which show that steel pipe has an elongation factor of at least 18%—more than sufficient to take all ordinary stresses and strains without breaking. As a material, steel can be rolled, formed, welded, forged, or cast. Types and shapes of pipe fittings that can readily be made are infinite in number, which means that all common and special requirements can be met easier with steel pipe.

It is this ductility which permits it to "live in the ground" secure against the normal settling and shifting of problem soils.

It is also this property of ductility which gives steel pipe the ability to withstand such abnormal shocks as surge, water hammer, earthquakes, cave-ins, washouts, floods and extreme temperature changes without cracking, shattering or leaking. Man-made abuses such as traffic vibration, blasting, and extreme pressure, are as easily conquered.

Examples of the great ductility of steel pipe are numerous. At Bakersfield, Calif., as a result of the earthquake of 1952, over 80,000 feet of another type of pipe ruptured and was replaced by steel, while at the same time steel pipe laid 3 feet underground was forced up through the earth by the quake, with more than 100 feet of pipe arching some two to three feet above the ground surface. This pipe remained service-



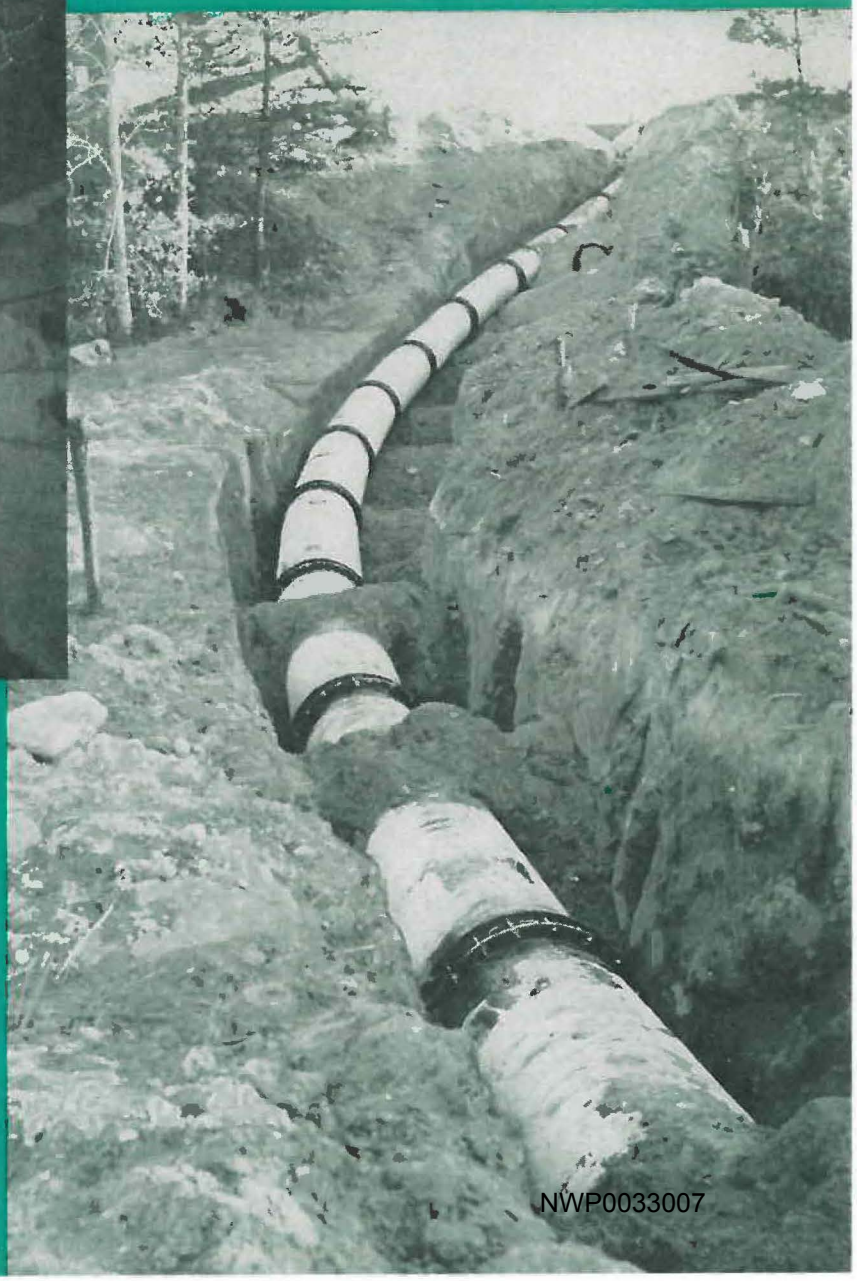
120 inch diameter, ¼ inch wall thickness, welded steel pipe supported by ring girders and steel bents on 60 foot centers. Maricopa County, Ariz.

NWP0033006

48" and 54" water lines laid along city streets in Philadelphia showing ease of following street contours.

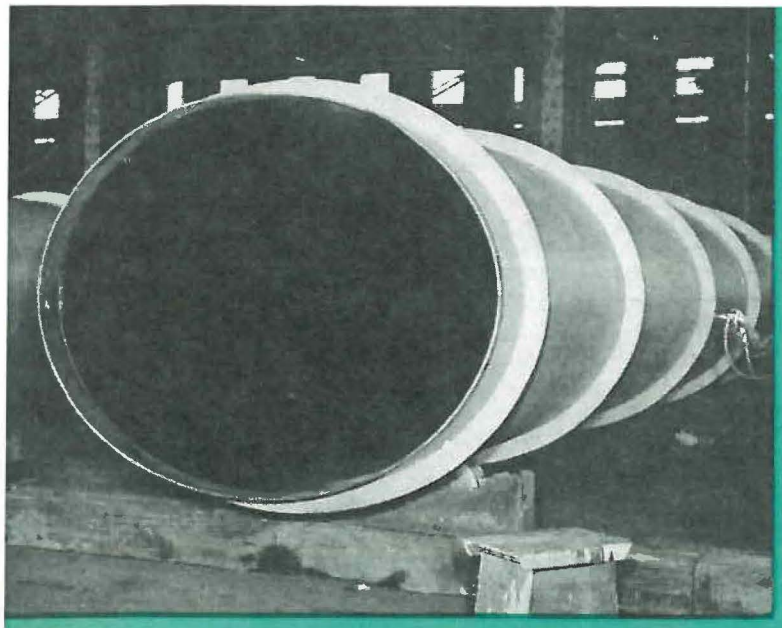
Steel water pipe line following curve of railroad—note long sections, straight lengths, and mechanical couplings.

Steel water pipe lines serve in air conditioning the Capitol, Library of Congress Bldg., Supreme Court Bldg. and wing of Senate Office Bldg. in Washington.

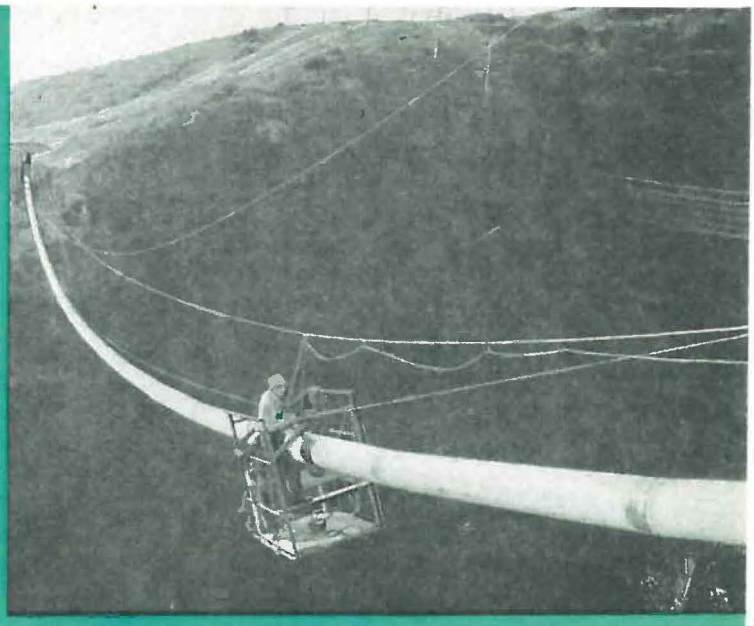


Steel water line, Greensboro, N. C. Long radius bend made with straight lengths of pipe and couplings.

NWP0033007



Welded steel elliptical pipe, 66" x 83" x ½" plate—spun coal tar enamel inside. An example of flexibility of design to meet restricted headroom.



Steel pipe line—16" in diameter—suspended across a 420 foot Canyon near Ventura, Calif. An excellent example of adaptability and strength.

able without developing a leak, and was eventually returned to its original position.

The resistance of steel pipe to washout is illustrated by an instance in which a group of piers were washed away from under 10′ diameter x ½″ thick steel pipe full of water, leaving an unsupported length of 115 feet. The deflection at the center of this unsupported span amounted to only 3½″, and the pipe did not break.

An exceptional feature of steel pipe which further illustrates its ductility is its capacity of being restored to service even after damage due to stronger abuse. There have been extreme examples in which large diameter steel pipe lines, installed above ground, after having collapsed under unpredictable vacuum conditions, sabotage or floods, were restored to their original condition by merely filling the pipe with water and rounding it out under pressure.

ADAPTABILITY

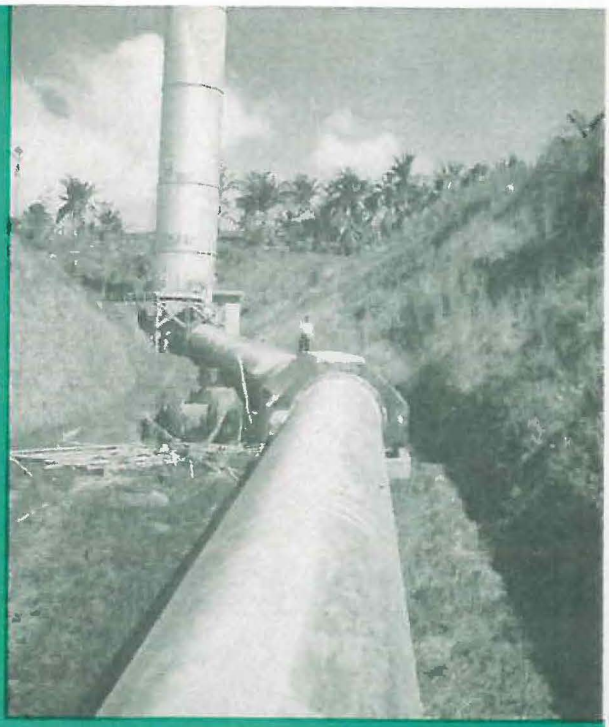
The physical flexibility or ductility of steel water pipe results in an equal flexibility in its wide variety of uses, especially in difficult terrain situations. It can be installed under water, in mud, clay, quicksand or peat bog, or tunneled under highways or existing pipe lines. It is the only type of pipe that can be laid above ground with confidence because it is so resistant to external damage.

Steel pipe can be installed on steep, rugged slopes, such as canyon walls, or down the sides of mountains. It is the only pipe capable of being supported over swamps on widely spaced piers by integral ring girders. Another example of its adaptability is the ability to be carried across wide canyons on flexible suspension bridges. In fact, steel pipe is the invariable choice of engineers when the going is the toughest.

The great variety of thicknesses, high physical properties, and sectional lengths in which steel pipe is available, enable the engineer to design his pipe line more accurately to meet whatever conditions he may encounter

"Wherever Water Flows
STEEL PIPES
IT BEST"

NWP0033008

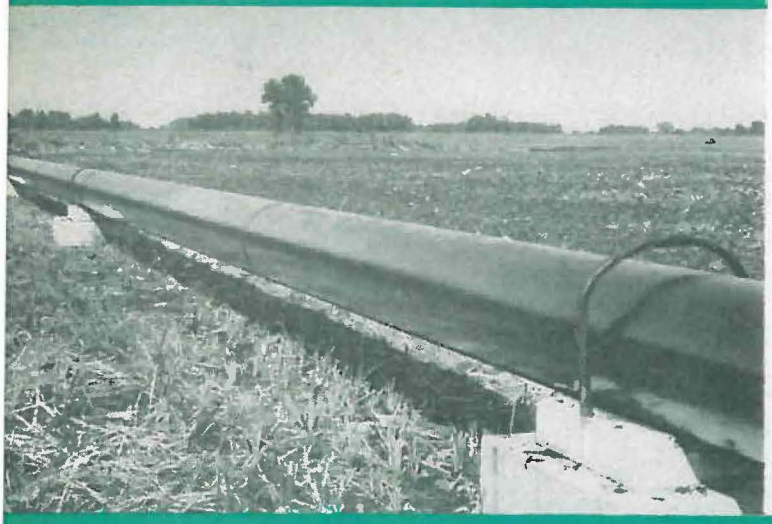


Section of large steel water pipe line near Manilla, P. I. which was intentionally collapsed to prevent use by Japanese. It was later restored to original shape by pressure, and is shown in use today.

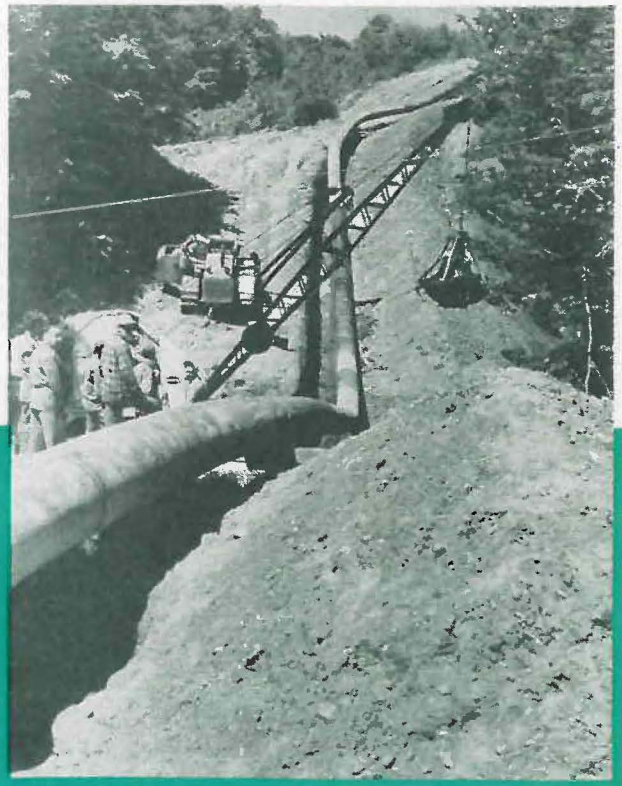
Steel pipe can be "shop fabricated" to meet the specific requirements of the field. If special fabrication in length, fittings or accessories is needed, it can be applied quickly and economically, yet "tailor-made" for the particular job.

Ease of transportation to and over difficult terrain, as compared with other heavier materials, adds to the factor of adaptability and represents a definite saving both in time and expense. For example, a section of lined, coated and wrapped 60″ x ⅜″ thick steel water pipe 40′ long weighs less than 12,000 lbs., whereas a comparable section of concrete pipe only 16 feet long weighs approximately 11 tons. Once in the field, steel pipe is easily handled and jointed—again resulting in a saving of installation cost. Due to its flexibility and strength, steel pipe can be assembled and joined in long lengths, above the trench, and then lowered into position. This is not possible with any other pipe material in use today.

Ductility and adaptability to job requirements—are major contributing reasons for the rapidly increasing use of steel water pipe by water works engineers and contractors across the country today.



24″ line crossing swampy ground, illustrating beam strength.



Steel pipe in rugged terrain—illustrating adaptability to any contours.

"Wherever Water Flows
STEEL PIPES
IT BEST"

NWP0033009

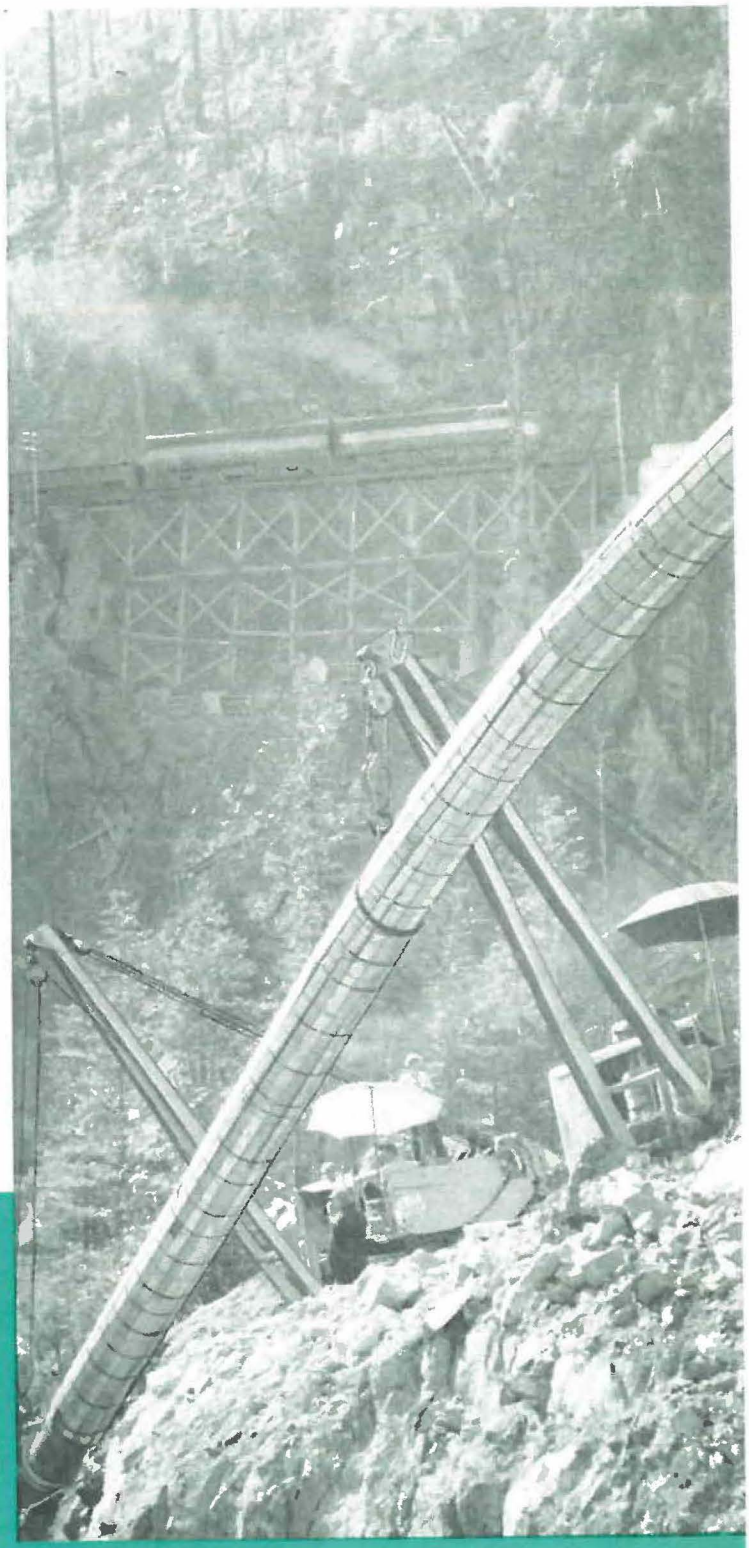
INSTALLATION ADVANTAGES OF STEEL PIPE

Steel water pipe has many positive advantages in transportation and field installation work.

The basis for these advantages is the fact that steel pipe possesses the greatest strength per unit weight of material of all types of water pipe. Therefore, for a given pressure, steel pipe will have the lowest weight per foot as compared to any other type of pipe.

This relative lightness reduces the cost of transportation from the shop to the job site, and permits lighter equipment being used. Handling of steel pipe in loading and unloading is expedited, particularly in rough or wet country. Because of this ease of handling, the cost of laying the pipe is reduced. The necessity of fewer field joints, as a result of the long lengths of pipe sections, and the availability of various types of flexible and water-tight field connections is of equal importance. All of this adds up to fast laying operations and overall economy.

Another advantage of using steel pipe is the saving which may be made in excavation and backfill operations over other types of pipe. This is possible because the clearance required for laying work in the trench is usually less than for other pipe. Therefore, a narrower and shallower trench can be used, which reduces to a minimum the amount of excavation, backfill, and bell holes required for the water line. Further savings are realized throughout the life of the pipe in the form of lower interest charges, no leakage losses, and a minimum of maintenance costs, when properly designed, constructed and protected.



A 24" line being lowered over a cliff in mountainous territory. The pipe is protected by wooden slats to prevent damage to coating.

NWP0033010

Thus the installation advantages of steel pipe over other types used for water systems can be summed up as follows:

1. Lower hauling or shipping costs.
2. Easier handling.
3. Fewer sections to handle.
4. Least number of field joints
5. Fewer bell holes.
6. Lower equipment costs.
7. Minimum of blocking.
8. Greatest flexibility in meeting field conditions.
9. Minimum amount of excavation and backfill work.
10. Greatest speed in laying operations.
11. Minimum maintenance costs.
12. Greatest economy.
13. No leakage or infiltration.
14. Greater protection of health of water users.

Eight 40 foot lengths of 36" diameter steel pipe—total weight 51,200 lbs. loaded on standard flat car.

Field coupling. Note narrow trench and long length of sections.

Laying steel water pipe in Cincinnati street—note narrow trench and fast follow-up behind excavator.

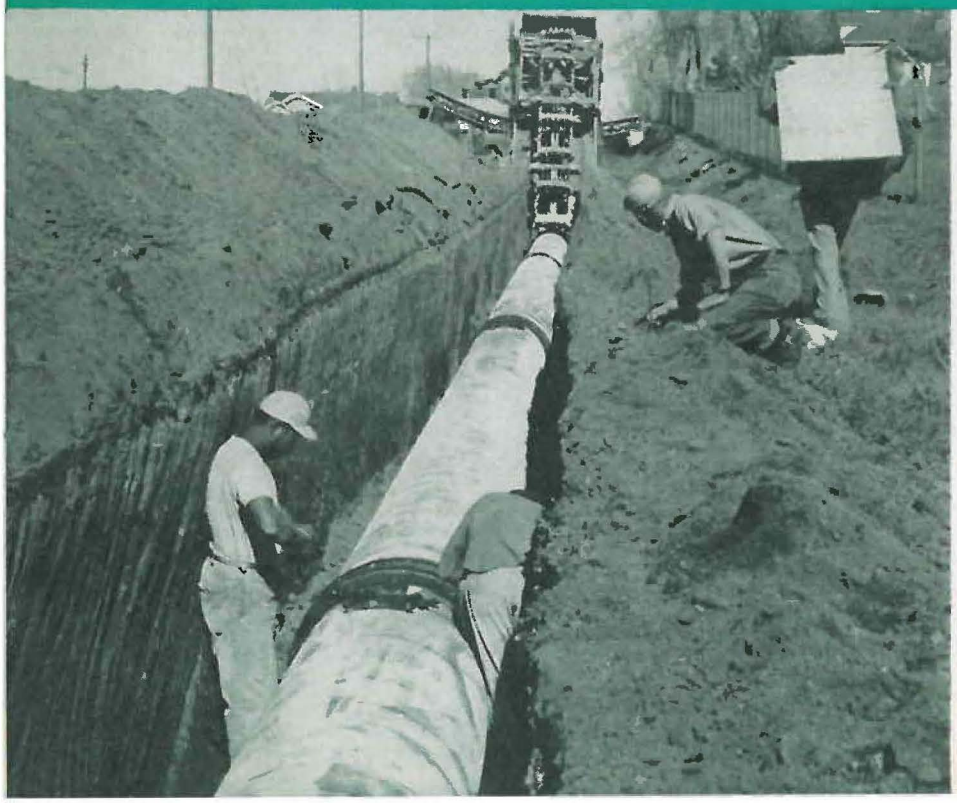
78" steel pipe being laid. Note narrow trench. Eighteen 40 foot sections of this pipe were laid in 8 hours on this job.

NWP0033011

Illustrating ease of handling and minimum need for manpower in laying 40 foot sections of 50" steel water pipe.

Underwater river crossing of 36" steel pipe line coupled and harnessed into 63 foot lengths in shop for delivery to job site. Pipe has coal tar lining, coating and wrapping.

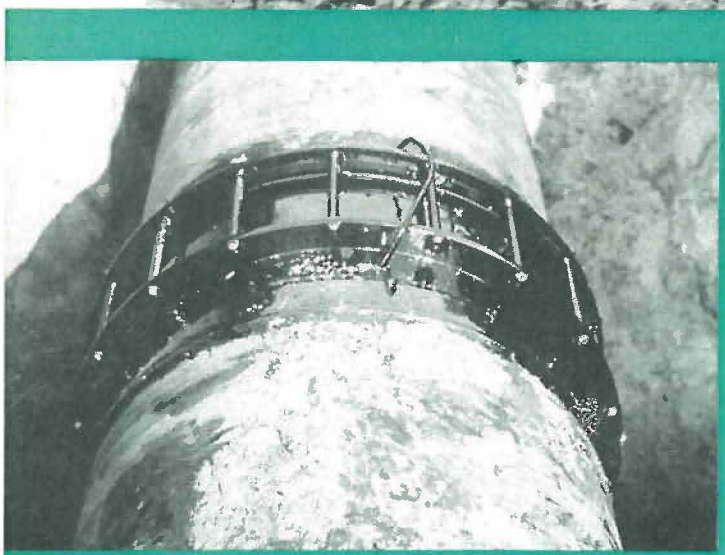
Example of narrow ditching in Portland, Oregon. Note also light equipment and ease of handling



Ditching and laying simultaneously with joints completed only three sections from ditcher.

"Wherever Water Flows
STEEL PIPES
IT BEST"

NWP0033012



Close up of mechanical coupling after application of protective coating.

Coupled, lined, coated and wrapped steel water line laid in rugged terrain, installed for U. S. Bureau of Reclamation.

NWP0033013

FIELD JOINTS

No water line is stronger than its joints. Steel pipe has the distinct advantage that *100% bottle-tight joints* are assured.

Allowance for leakage at joints is eliminated where steel pipe is specified. This means conservation of vital water, full advantage from the designed capacity, protection against washouts and costly joint maintenance.

Joints in steel water lines are fewer, because of longer pipe lengths; and generally easier and faster to install. They lend themselves to good work organization, provide uniform quality and trouble-free performance. They test tight and stay tight.

MECHANICAL COUPLINGS

Dresser Couplings are the most widely used mechanical joints on water lines. Their rubber-pack seal and built-in flexibility provide unique advantages in field installation of steel pipe. Deflections at joints are accommodated by the coupling, allowing many curves to be accomplished without specials or field bending of pipe. Expansion-contraction stresses are absorbed in the coupling, an advantage of particular importance in above-ground installations and in connections to valves, fittings and machinery. With Dresser Couplings, no beveling, grooving, belling, or exact cutting is required. Perfect alignment of pipe ends is not necessary to effect a permanent seal. No damage to lining takes place during installation, since there is no heat applied. In addition to regular couplings, Dresser mechanical joints are available in reducing sizes for joining steel to cast iron and for radical reductions in steel pipe sizes.

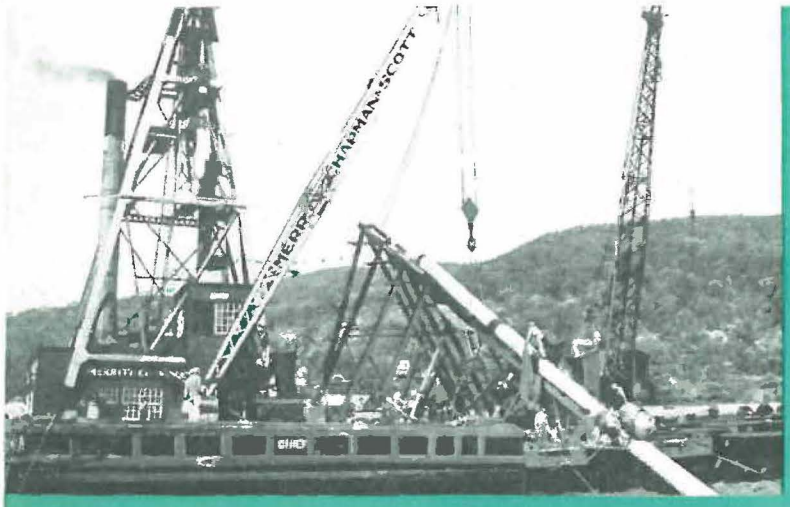
FIELD WELDED JOINTS

A common field welded joint is the single butt weld where ends of pipe are joined by laying a weld around the outside circumference of carefully butted pipe ends. Where qualified welders are available and adequate inspection techniques can be employed, this type of field joint offers superior strength since the pipe, in effect, becomes a continuous structure.

Other types of field welded joints include the double welded butt joint, where a second bead is laid on the inside, and slip bell joints which are welded at the end of the lap and sometimes also on the inside of the pipe. Relatively expensive butt strap joints are employed where unusual circumstances dictate special fitting up of large pipes above-ground.

DRIVE JOINTS

Drive joints are used generally for light gauge low pressure steel pipe under 30" diameter. A slight bell at one end is heated until it expands. The plain end of the next pipe is driven in to a full seat. When the expanded bell cools, it contracts, making a tight joint, which is further sealed by the protective coating, sufficient to withstand 150# pressure.



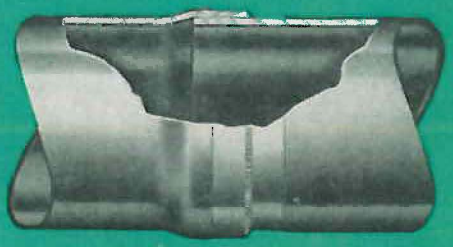
Three 40' lengths of 24" pipe, welded into a single 120 foot section for underwater crossing. The section has been placed in a sloping pipe skid which will guide it toward the river bottom.

Placing the gasket in position to assure a leakproof flexible joint.

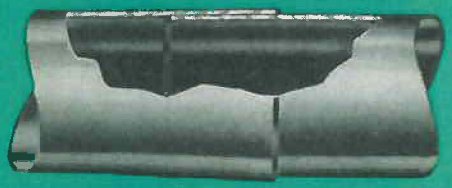
NWP0033014

Butt welded field joint, welded outside and inside.

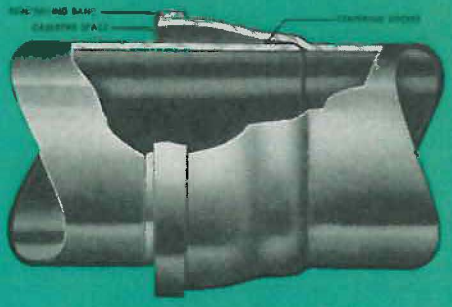
Butt welded field joint, welded outside only.



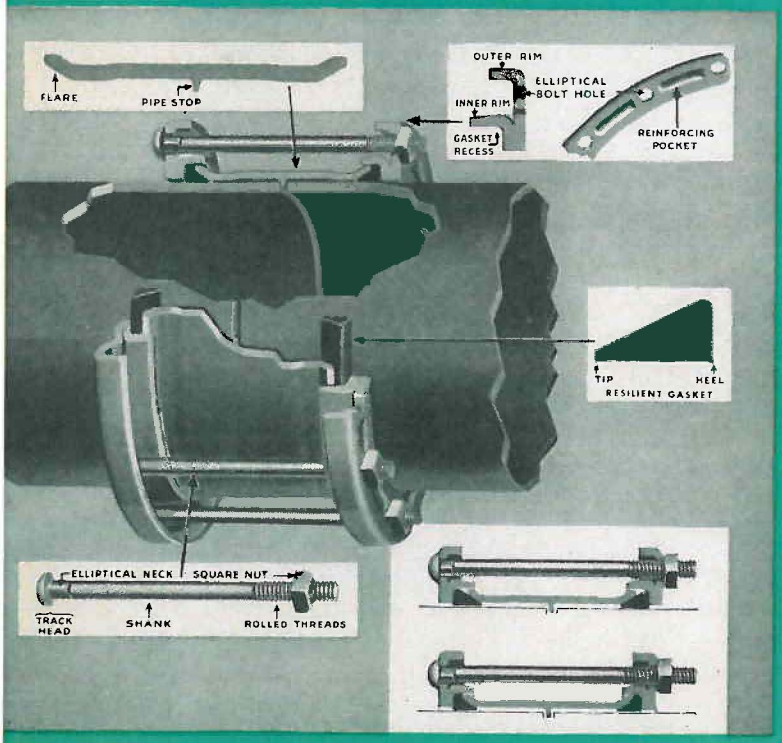
Lap welded field joint.



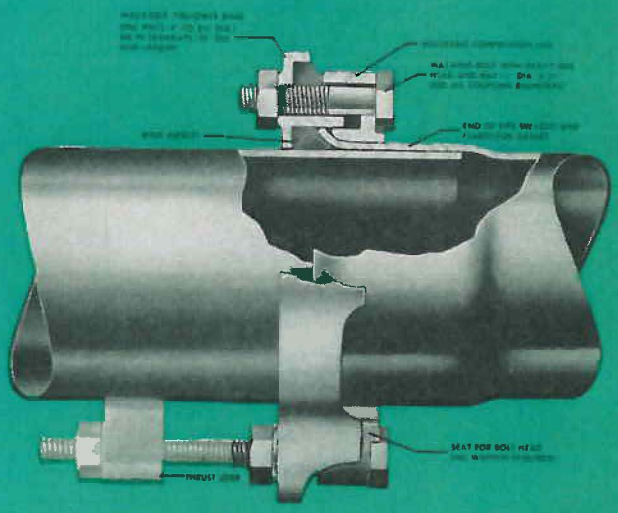
Driven field joint.



Caulked field joint.



Cutaway view of Dresser steel coupling. Picture in lower right hand corner shows position of gasket before and after tightening.



Bolted field joint.

NWP0033015

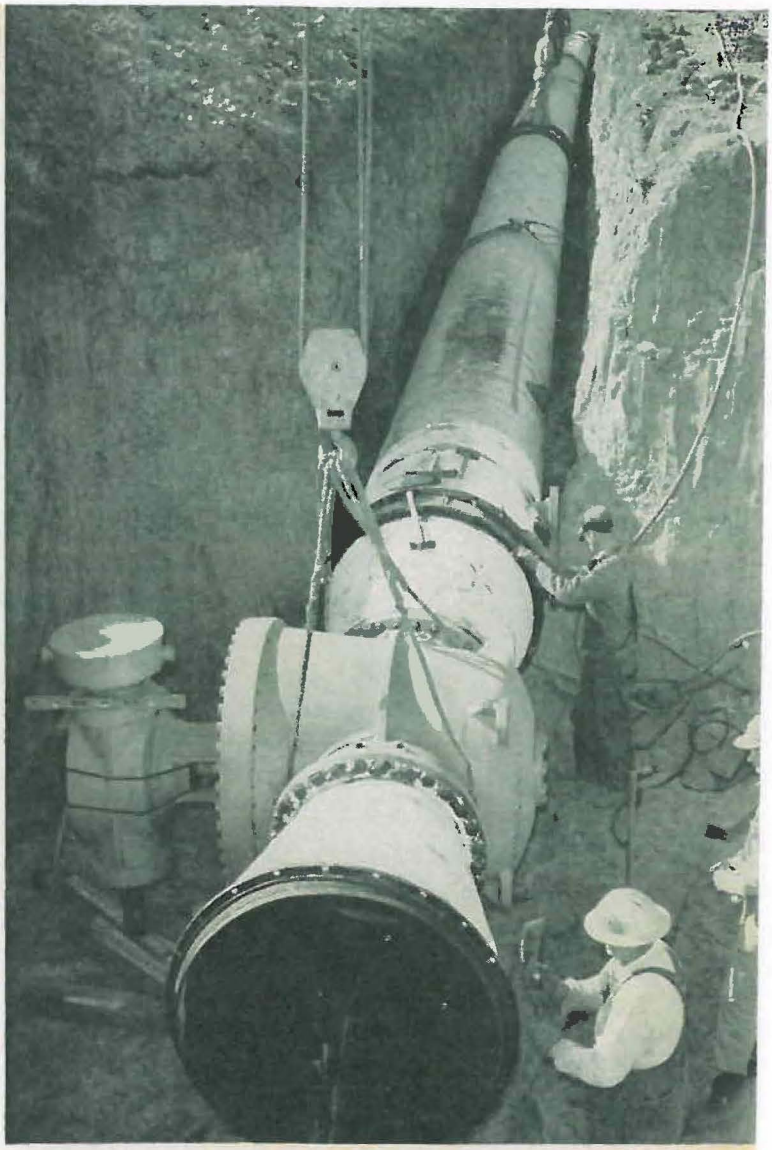
FLANGED JOINTS

This type of joint consists of flanges welded on the ends of pipe, bolted together and sealed with a gasket. It is used for connections at valves, fittings and machinery and provides a rigid connection. Close pipe fitting and line-up is necessary with flanged joints. Main advantage of this type joint is that it affords relatively easy access into the line for removal of valves, pumps and other equipment for servicing.

SPECIAL COUPLINGS AND FITTINGS

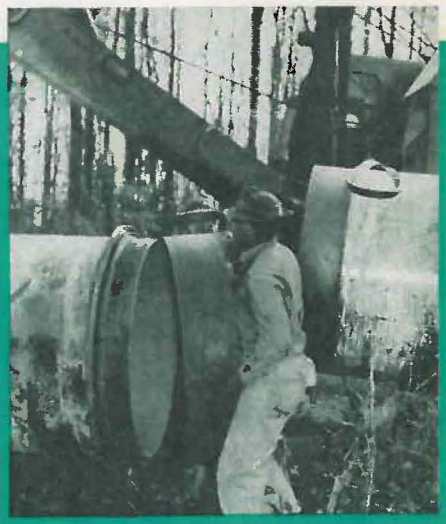
One of the definite advantages of steel pipe is that it is readily adaptable to the construction of fittings and junction pieces required in a pipe line. This feature is especially valuable when mechanical couplings are used. While standard couplings will meet most requirements, certain applications may arise where joints of special design are needed. Mechanical joints are particularly adaptable to the solution of special joining problems and are available in tees, ells, wyes and line caps.

A great variety of appurtenances such as air valves, gate valves, blowoffs, man-holes and pass-holes and expansion joints and anchors, is readily available for use on steel pipe water lines when needed.

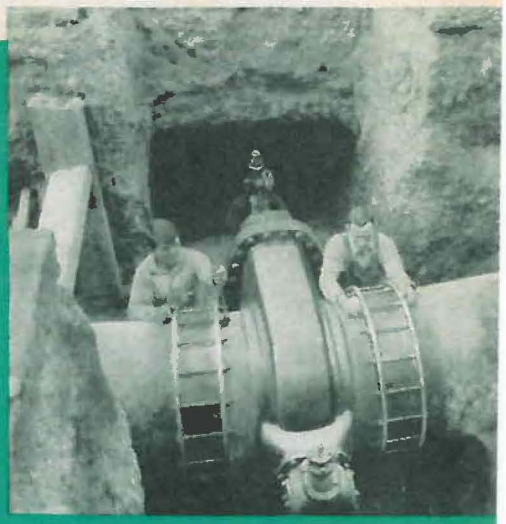


Valves are easily set in steel water lines using mechanical couplings. Narrow trenches required mean minimum excavation.

Butt welding sections of 60" diameter coated and wrapped welded steel pipe. This is a major water supply line for the city of San Francisco.



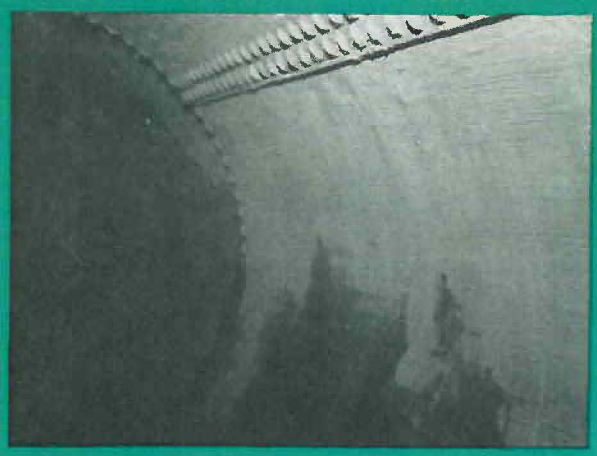
Putting on middle ring of mechanical coupling.



A 48" valve setting with mechanical coupling.

NWP0033016

Lining a 40 foot length of 96" steel pipe with coal tar enamel at the fabricating plant.



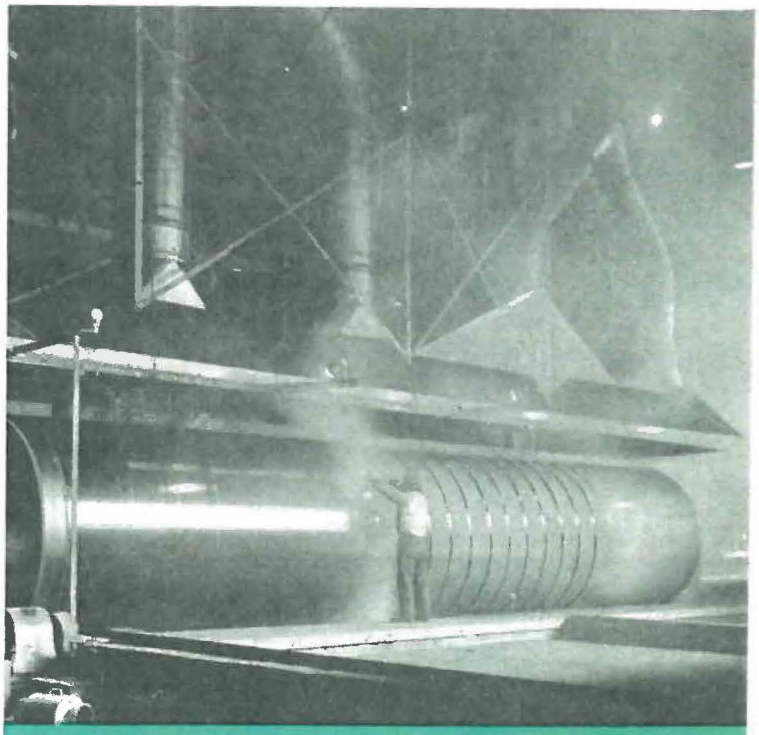
Interior of 48" pipe after 28 years' service. Interior and exterior were hand brushed with coal-tar enamel. Samples analyzed in laboratory showed no change in physical characteristics and no moisture absorbed in the 28 years of use.

Section of coal-tar enamel coated pipe with coating cut away to expose pipe which was laid in "hot" soil, with heavy acid content 10 years previous. Note that exposed pipe is in perfect condition.

Interior view of steel water pipe lined with coal-tar enamel, showing high gloss achieved by the spinning process and resulting in a very high flow co-efficient.

NWP0033017

PROTECTIVE LININGS AND COATINGS



Application of coal-tar enamel simultaneously with asbestos felt wrap.

Specially prepared and applied protective linings and coatings are recognized as beneficial to the efficiency, life and operation of a steel pipe water line. These linings and coatings are properly formulated to permanently resist all of the corrosive factors which may be encountered.

The product selected for the protection of the pipe must, therefore, meet all of the five major requirements of an effective lining and coating material. It must have:

1. High resistance to moisture penetration.
2. High electrical resistivity.
3. High resistance to soil acids, alkalis, and salts.
4. High physical stability.
5. High resistance to dissolution in water.

In addition to these very basic requirements, the material selected should have other important characteristics. These include high mechanical strength, durability, smoothness (for lining), permanent flexibility, ease of application, high bond strength, no effect on water quality, and, of course, reasonable cost. It should, to the greatest degree possible, offer resistance to soil stress, stray currents, bacteria, vegetation, abrasion, freezing and erosion.

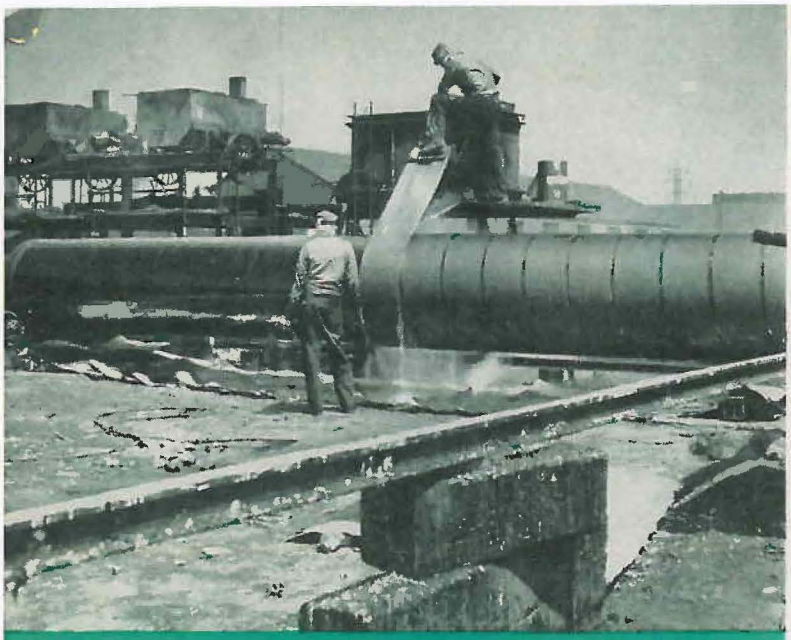
Among the linings, coatings and wrappings used at the present time are: coal-tar enamel, asphalt, cement mortar and asbestos felt. Each has advantages which must be considered in the light of conditions to be met in the pipe installation being undertaken. The most commonly used lining and coating is coal-tar enamel, for which the A.W.W.A. has developed standard specifications, C203 and C204.

During the last fifty years, coal-tar enamel coatings and wrappings have been used successfully to protect the exterior of thousands of miles of steel pipe lines carrying water, natural gas, and oil.

While it requires reasonable care in application, once properly applied, it is universally recognized as providing effective, economical and long-life protection.

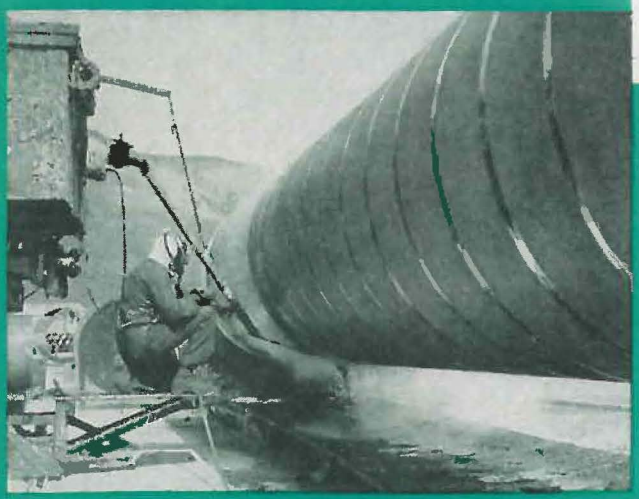
A spun application of coal-tar enamel provides the interior of the steel pipe with a lining which is the smoothest waterproof surface currently available. The lining of coal-tar enamel has a thickness of approximately 3/32 inch. Consequently, there is practically no encroachment on the internal diameter of the pipe. Because of these attributes, steel pipe with a spun coal-tar enamel lining has the highest flow capacity of any type of water pipe.

NWP0033018

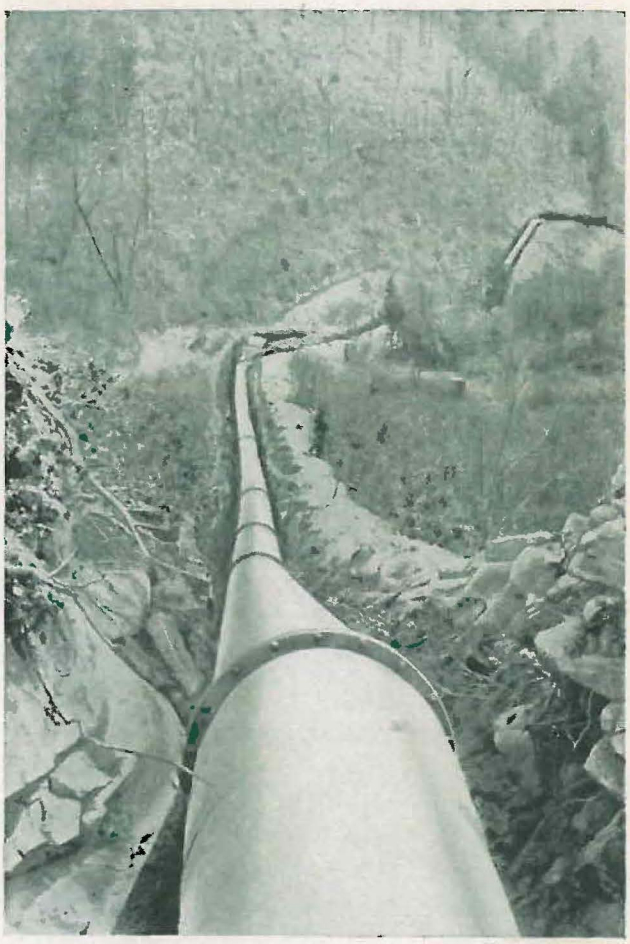


Applying coal-tar enamel and wrapping to 48" pipe in the field.

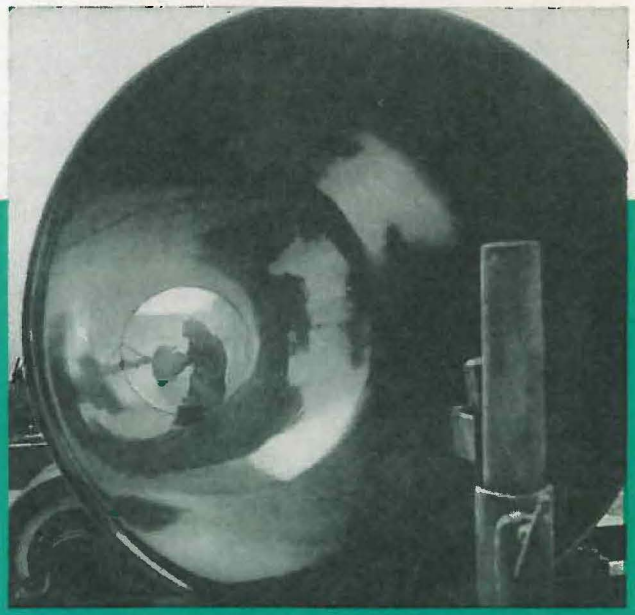
Workman pouring protective coal tar enamel coating on mechanical joint.



Asbestos felt wrapping on 61" x 3/8" wall welded steel pipe.



Part of a 10 mile 30" steel water pipe line near Tamaqua, Pa., The first project to use spun coal tar enamel lining, installed in 1931. A recent check shows no reduction of high flow capacity, "C" equals approximately 145, and no deterioration of coating.



Inside enameling, large diameter steel pipe for San Francisco water line

NWP0033019

SPECIFICATIONS

When designing your steel pipe line refer to the following American Water Works Association Specifications.*

C201—Standard Specifications for Electric Fusion Welded Steel Pipe of sizes 30 inches and over.

C202—Standard Specifications for Steel Water Pipe of sizes up to but not including 30 inches.

C203—Standard Specifications for Coal-Tar Enamel Protective Coatings for Steel Water Pipe sizes 30 inches and over.

C204—Standard Specifications for Coal-Tar Enamel Protective Coatings sizes up to 30 inches.

C206—Standard Specifications for Field Welding of Steel Water Pipe Joints.

C207—Tentative Standard Specifications for Steel Pipe Flanges.

C208—Standard Dimensions of Steel Water Pipe Fittings.

When requesting bids or placing orders the above specifications should be supplemented with the following details:

(1) Nominal inside or outside diameter of pipe.

(2) Thickness of steel plate material.

(3) Grade of steel plate material.

(4) Laying length of pipe sections.

(5) Working water pressure for each diameter and plate thickness of pipe.

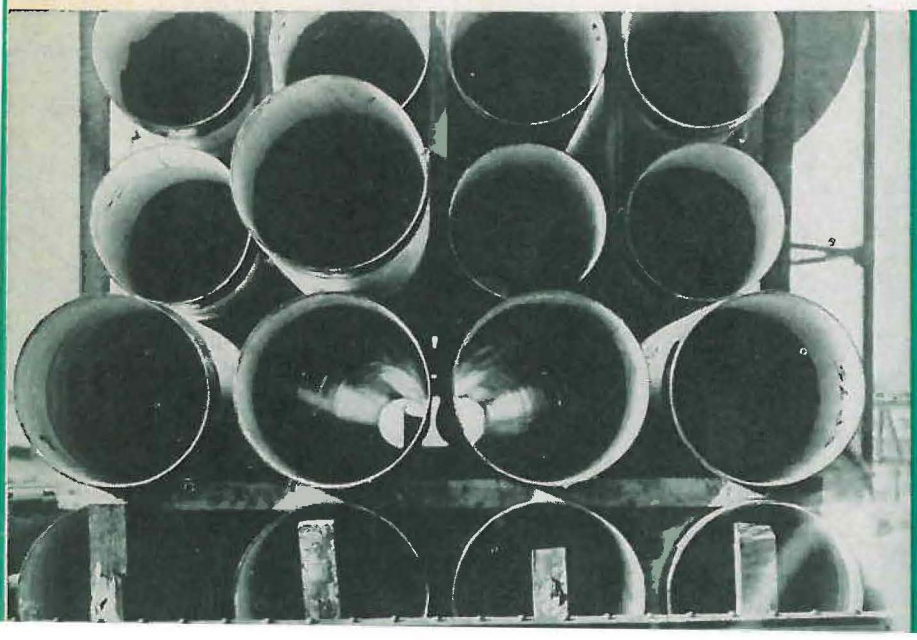
(6) Type of field joints desired.

(7) Alignment and profile of water line.

(8) Type of protective coating and lining.

(9) Destination.

*A.W.W.A. Specifications may be obtained from the
American Water Works Association
521 Fifth Avenue
New York 17, New York
or any steel pipe manufacturer.



A gondola car loaded with 800 feet of 20" coal tar enamel lined, coated, wrapped and whitewashed steel pipe ready for unloading

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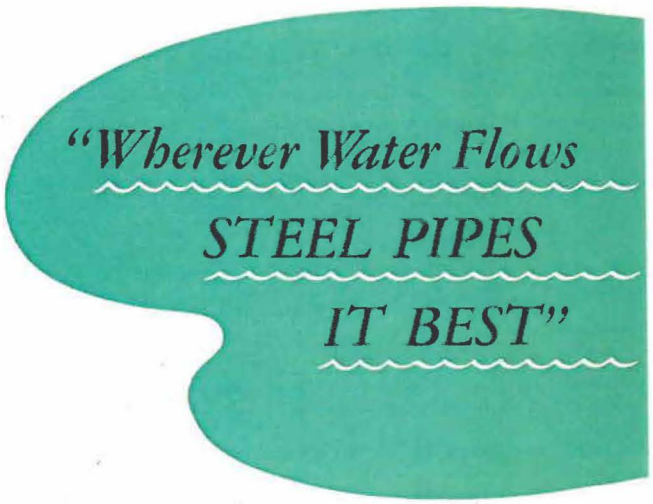

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MOUNT ST. HELENS UPDATE: ...STILL DIGGING OUT...

The mouth of the Mount St. Helens volcano and its dome.

By Pam Wilkinson

Northwest Pipe & Casing Company, Clackamas, Oregon, manufactured approximately 3,600 feet of 60" O.D. pipe to be used in a pipeline to prevent imminent flooding from Spirit Lake, Mount St. Helens, Washington. The 60-foot lengths, .375 wall thickness, were prepared on an emergency basis and are finished with a special 6-inch deep weld bell in order to permit sufficient deflection in the mountain terrain.

Spirit Lake, located on the north slopes of the Mount St. Helens summit, first received national attention as the homesite of Harry Truman, an 84-year-old man listed as missing following the May 18, 1980, eruption. Truman had refused to evacuate, saying that he would never leave his home. Today Spirit Lake, once a wilderness paradise, has no overflow into the Toutle River. All natural outlets are clogged by volcanic debris, and the water level has risen dangerously.

Experts previously thought that Spirit Lake, whose level rose 200 feet as a result of the eruption and another 50 feet by rain and snow runoff since then, would remain at safe levels until 1985. However, the lake has risen much more rapidly than anticipated, causing the current crisis.

Spirit Lake's natural outlet into the North Fork of the Toutle River was walled-off by volcanic material deposited across a valley at

Spirit Lake from Mount St. Helens. Logs look like toothpicks.

Mount St. Helens "lunarscape." Lower right edge of photo shows part of the debris dam blocking the lake's natural outlet into the North Fork of the Toutle River.

MOUNT ST. HELENS UPDATE:

the northwest corner of the lake, creating a 4,000-foot-wide dam. This pyro-plastic dam, as it is termed by the U.S. Army Corps of Engineers, is extremely unstable.

According to a Corps spokesman, core-analysis of the material indicates that the upper level of debris, ranging in depth up to 40 or 50 feet, was deposited by volcanic ash. The middle layer appears to be a blast deposit of pebble-sized and larger rock fragments of the old mountaintop, a layer believed to be 10 to 15 feet thick. At the lowest level is avalanche material from the massive landslide preceding the 1980 eruption. In places, cores up to 150 feet deep have been drilled.

Numerous erosion channels 40 to 60 feet deep have riddled the dam, in addition to sinkholes, which indicate that the upper 40-foot crust of debris is unreliable. In digging the pipe trench, workers also have found building-size blocks of ice thought to be remains from volcanic glaciers.

Elting, Inc., of Clackamas was awarded a $3,119,914 contract by the U.S. Army Corps of Engineers to ease the flooding danger. Northwest Pipe & Casing bid directly to the contractor to supply the pipe for drainage. Officials, including representatives from the Corps of Engineers, from the Federal Emergency Management Agency, and from the U.S. Geological Survey agree that dam failure could release torrents into the Toutle, Cowlitz, and Columbia rivers up to four times greater than the mud flows following the May 18, 1980, eruption. Downriver, the communities of Castle Rock, Longview, and Kelso are among those endangered.

Specifications for the Spirit Lake Project include the pipeline laid from the lake to a stilling basin, where silt will settle from the lake water before draining through another channel into the headwaters of the North Fork of the Toutle River. Lake water is to be pumped from a barge-mounted system at the rate of up to 1,350 gallons per second. The 40-by-160-foot barge supporting 20 pumps is intended to be continuously operational until July 1983. If the water level has receded satisfactorily at that time, the pump station will then be used on an as-needed basis.

However, the pumping procedure is not a final solution to the flooding danger, and the U.S. Corps of Engineers will develop a permanent plan for relieving flood threat following the completion of experimental drilling into the debris. There is yet no provision for a permanent outlet for the lake.

The quality of water in Spirit Lake is another problem, and its possible impact on water quality in the Toutle River. There is some indication that harmful bacteria may be pro-

Overlooking Spirit Lake, Mt. St. Helens

Laying pipe, Spirit Lake, Mount St. Helens

Laying pipe, Spirit Lake, Mount St. Helens

duced in the lake, an understandable development in a body of water which is essentially becoming stagnant. However, the agencies governing the project believe that the threat of flooding supercedes that of potential water quality; and further questions are to be addressed when the flood danger is alleviated.

In the meantime, limited plant and animal life is returning to the lakeshore. Inch-high fir seedlings have begun sprouting through the ash, and bees and other insects are seen. Deer tracks also have been sighted.

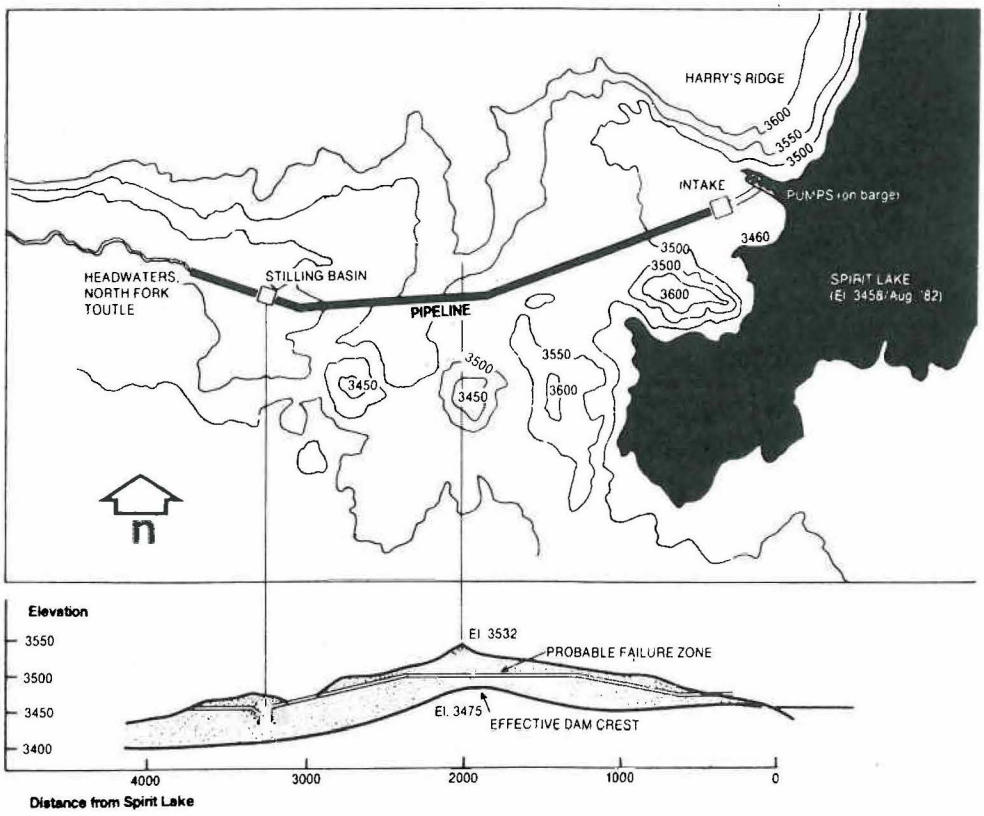
Members of the U.S. Geological Survey keep tabs on the Mount St. Helens rumblings. Geology markers, orange square-foot target boards mounted with prisms which can be monitored with laser or other survey equipment, have been placed inside the crater and on the dome. With the upward pressure of new lava, the markers spread apart while observers determine the rate of deformation.

Twelve to 15 targets are spotted around the dome with instrument sites on the four sides. The western side of the dome deforms more than the other sides; and the last non-explosive eruption, occurring in August, added a new lobe at the top and northwest dome edge.

Financing for the $11 million Spirit Lake Project is through federal funds released last August when President Reagan declared a state of emergency. The emergency designation frees unlimited federal funds for completing the project which is coordinated by the Federal Emergency Management Agency. Pipelaying began on September 29; completion date for the pumping project is November 1, prior to the onset of winter and inclement weather.

I specially wish to thank Northwest Pipe & Casing Company for assistance in preparing this article. Not only did Ralph Elle, Herman Adcox, and their staff provide photos and news clips from the OREGON JOURNAL and the OREGONIAN, they also made it possible for me to visit the Northwest Pipe facilities in Clackamas and Portland which will be featured next month in PIPELINE. -pfw-

Laying pipe, Spirit Lake, Mount St. Helens.



Route of the pipeline on the flanks of Mount St. Helens, leading from Spirit Lake into a stilling basin, then into the headwaters of the North Fork of the Toutle River. Pipe for the line was produced by Northwest Pipe & Casing Company, Clackamas, Oregon.

NORTHWEST PIPE & CASING CO.

NWP0033027

Laying pipe, Spirit Lake, Mount St. Helens

Laying pipe, Spirit Lake, Mount St. Helens

MOUNT ST. HELENS UPDATE:

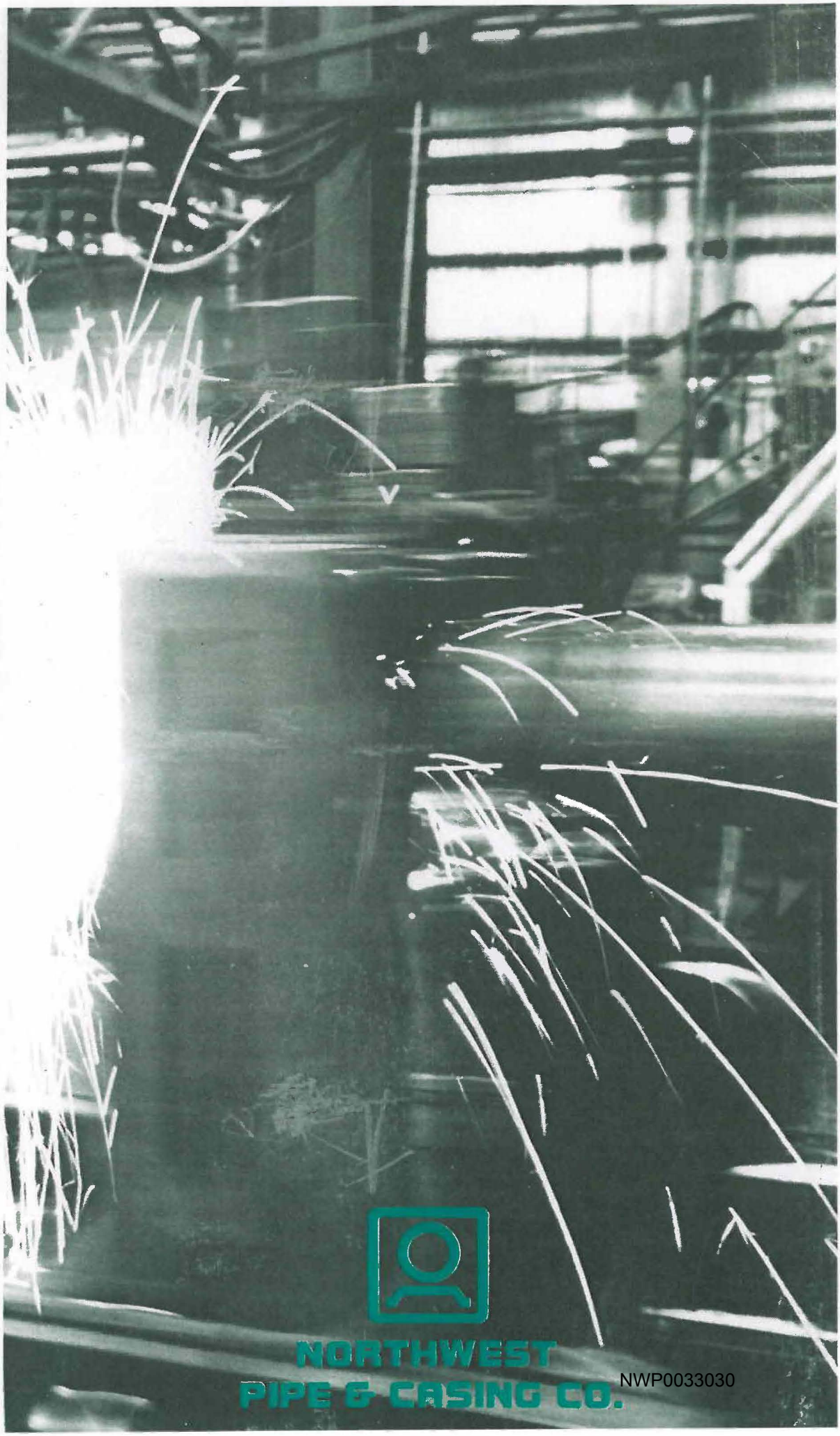
...STILL DIGGING OUT...

NORTHWEST PIPE & CASING CO.

EXHIBIT S-24-1.9

PIPELINE

DECEMBER
1982



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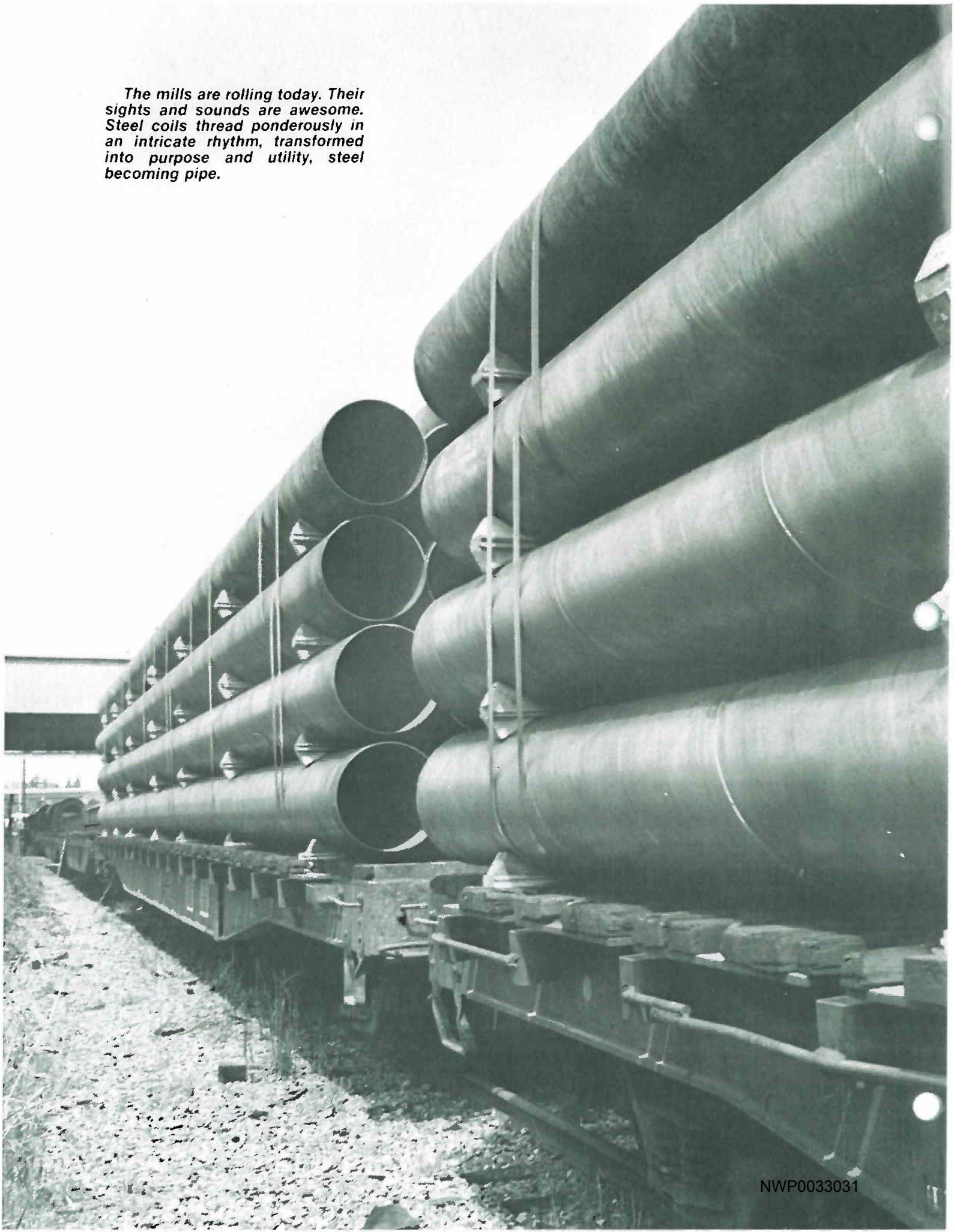
The mills are rolling today. Their sights and sounds are awesome. Steel coils thread ponderously in an intricate rhythm, transformed into purpose and utility, steel becoming pipe.



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NORTHWEST PIPE & CASING CO.

by Pamela Wilkinson

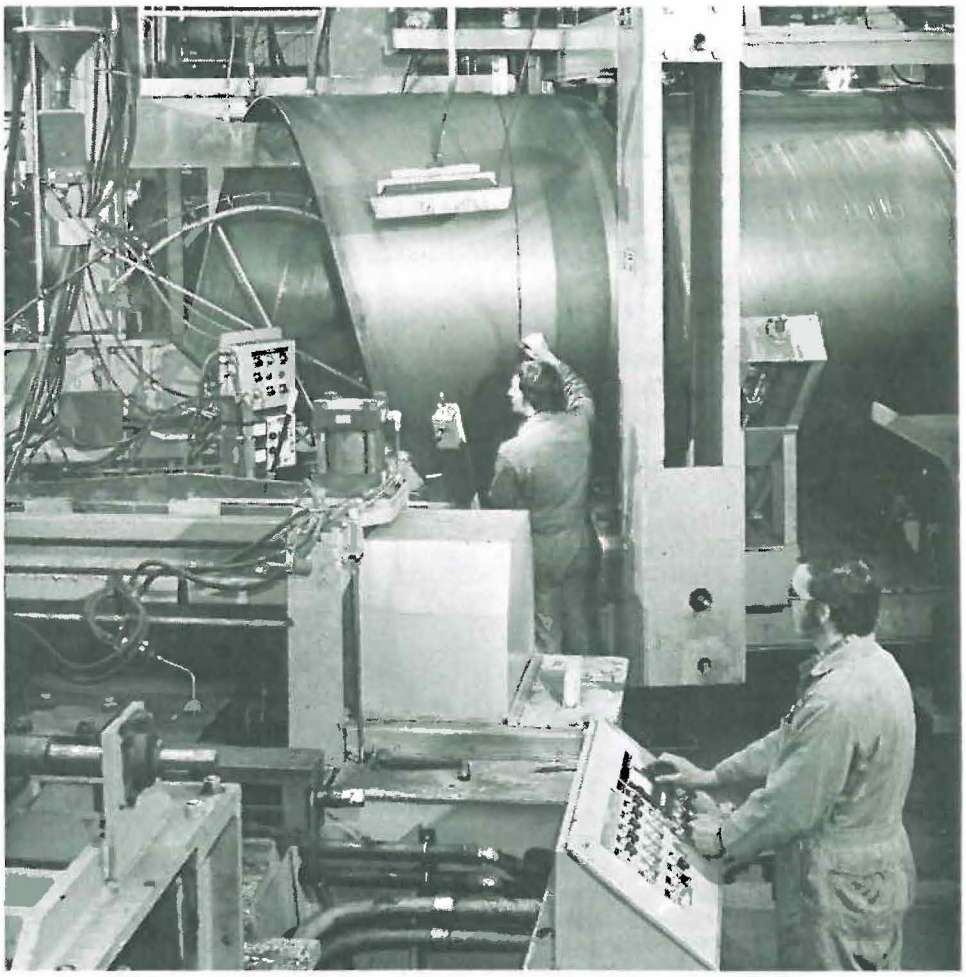
Most of the steel used by Northwest Pipe & Casing Company, Clackamas, Oregon, comes from U. S. Steel at Provo, Utah, with some import, primarily French. Northwest operates a total of nine mills: 4 ERW which produce pipe from 3" O.D. through and including 16" O.D., and 5 spiral mills producing pipe ranging from 12" O.D. to 154" O.D.

"We actually have produced 154" O.D. pipe," says Herman Adcox, Vice President. "That's the largest spiral pipe ever made anywhere. You could have set a regulation basketball net inside the pipe, shot high baskets, and never touched the top. You could have driven a truck through that pipe. It was made and used for a coal-scrubbing operation."

Northwest Pipe & Casing, incorporated in 1966, began making pipe in 1967. Ralph C. Elle, Sr., President, previously had spent 33 years in the pipe business; and accounts differ as to the circumstances of his departure as Chief Engineer from Beall Pipe in Portland. "We had a parting of the ways," says Elle.

Following several years in retirement and after obtaining two tube mills formerly used at Beall and in which he had participated in the designing, Elle founded Northwest Pipe & Casing. In February 1982, Northwest bought Beall from L. B. Foster, and presently uses those facilities as a second plant. "I've told Ralph many times," says Adcox, "that one of the finest points of that purchase was to see him buy the company that fired him years ago. There aren't many people able to do that."

While there are some stock options for employees, Northwest Pipe & Casing remains a closely held corporation with stockholders mostly drawn from among those



78" O.D. x 5/16" pipe, for use by the City of Seattle.

110" O.D. pipe, used as water conduit by the City of Denver.

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Portland businessmen who originally backed the venture in the late 1960's. "We are basically able to run the company and to make money for our stockholders," Adcox explains. "We are stable. Beall was our largest competitor. With our financial background and history, we could continue in this present economy for the next 20 years and still stay healthy."

Adcox, formerly with Continental Airlines, has been with Northwest Pipe since the early days. When he began selling for Northwest, the company marketed no farther east than central Idaho because freight costs were thought to be prohibitive. Yet Adcox believed that Northwest could expand into other areas, was given the go-ahead, and spent three weeks swinging through Nebraska, Kansas, and Oklahoma. He sold three carloads on that initial trip; and today, 43 percent of Northwest's pipe sales are east of Colorado.

"Our motto is QUALITY PRODUCTS FROM A SERVICE-MINDED MANUFACTURER, and I truly believe that," says Adcox. "We will work with our customers, and there are things that must be done to take care of them. We sell throughout a wide area and have developed business in mid-America so that we have a 12-month operation. Those accounts are the backbone of our business. There are a number of good, legitimate stocking warehouse distributors who carry our pipe. Among them are many NASPD members such as Tubular Steel, Valley Steel, Marmon/Keystone, Vinton Pipe, National Pipe, and Paleon, for example."

Northwest is highly diversified; another reason that the company has been successfully able to carry on during the present economy. One primary market includes the aforementioned warehouse distributors.

"We carry the finest inventory of pipe," says Adcox. "We fill orders almost on a grocery store basis." And indeed, an invoice may list only one or two pieces of a given pipe dimension, three or four of another, and so on.

Ralph C. Elle, Sr.
President
Northwest Pipe & Casing Company

"I have been competitive all my life," muses Ralph Elle. "I like to build and to see things grow. That's what I like about this business — it's fun, it's competitive, and our company has been growing for 15 years."

At the age of 74, Ralph C. Elle, Sr., President of Northwest Pipe & Casing Company, is one of the oldest active engineers in the state of Oregon. He is a major booster of Oregon State University and is a member of the President's Club. A multi-faceted individual whose youthful face and thoughtful eyes belie his snow-white hair, he is a quietly articulate man with a comfortable presence. The atmosphere of the company offices emanates from Elle; Northwest Pipe has a shirt-sleeves kind of headquarters suffused with a family feeling.

An avid golfer who still enjoys walking rather than riding in a cart, Elle carries a 16-handicap — "He usually plays better than that," interjects Herman Adcox — and plays three times a week. He celebrated his fourth hole-in-one on October 20, at Columbia-Edgewater.

Among his employees, aside from being the boss, Elle is noted for his green thumb. He raises orchids — two greenhouses full — and also cultivates between 60 and 70 varieties of fuschia. The company grounds are landscaped with plants and shrubberies grown from his slips, and Elle frequently brings in flats of plants which he gives away. Recent offerings were Thanksgiving cactus, jade plants, and prayer plants.

Elle began working in the pipe industry in 1931, following his graduation from college. He was Chief Engineer for Beall Pipe and spent 33 years with the company before leaving. Elle has designed and built a number of mills and designed the end-trimming and test machines used by Northwest Pipe today.

"Most of our business is in little bits of this and that," says Elle. "Business is down now; but as a smaller company, we can make decisions and do things our own way. You might say that I've come full circle," he smiles. "I'm back where I started, in pipe and owning the company I once worked for."

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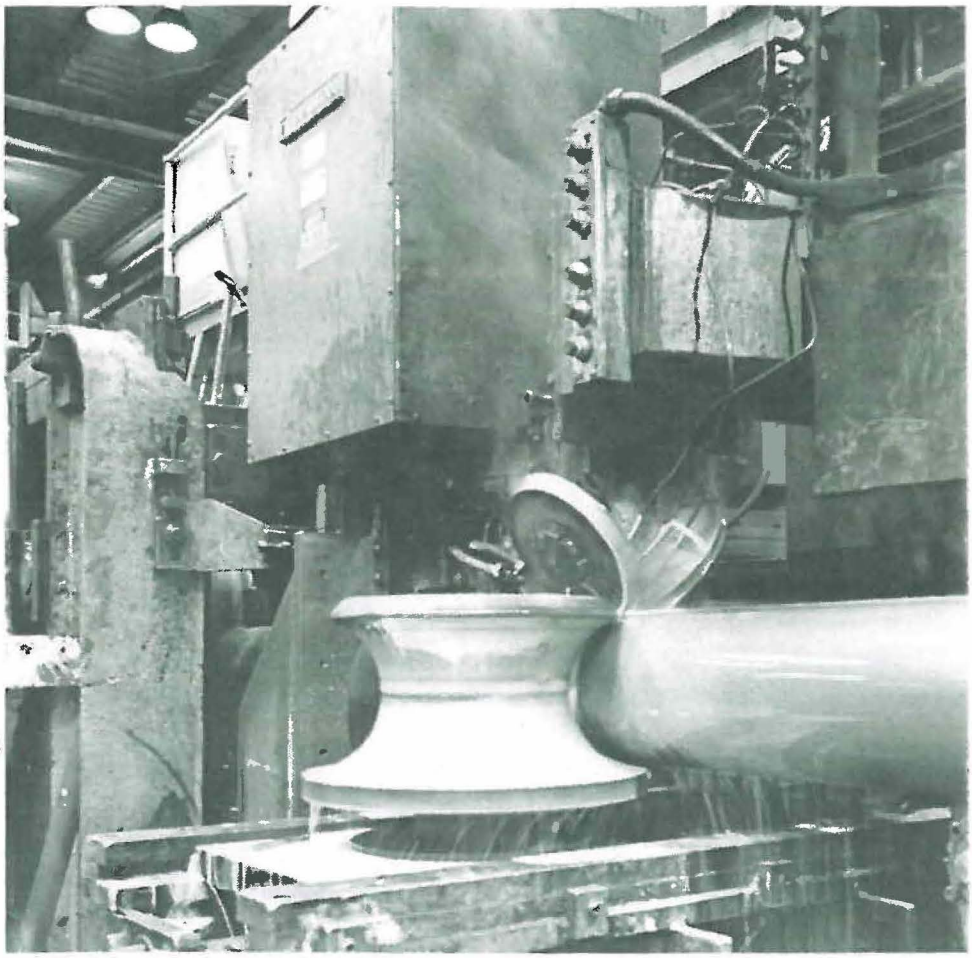
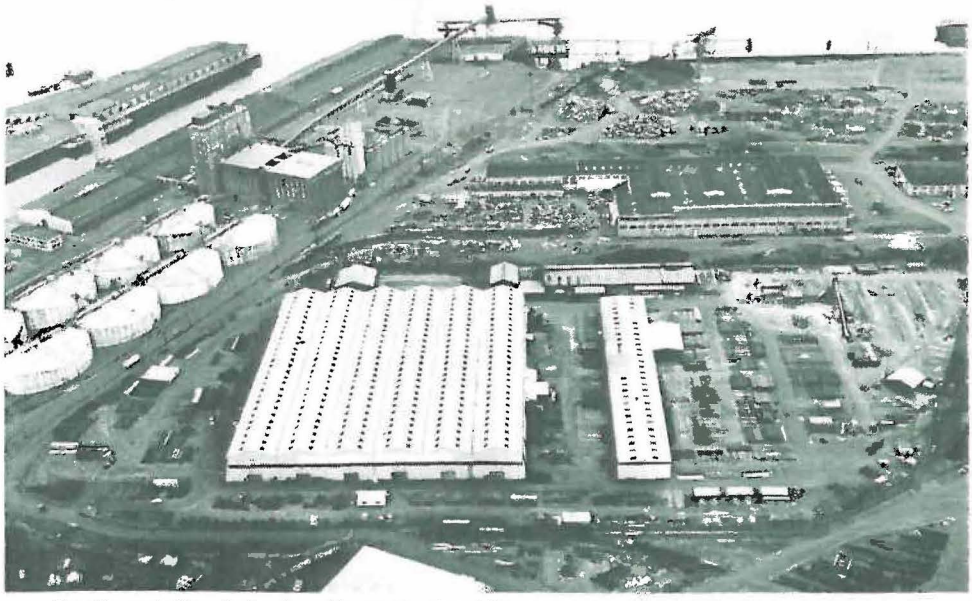
NORTHWEST PIPE & CASING CO.



Northwest Pipe & Casing, Clackamas. 16" O.D. ERW mill. 12" O.D. pipe shown at weld station.



Northwest Pipe & Casing, North Portland Plant, September 1982. Photo courtesy of the Port of Portland.

Providing pipe for utilities, such as waterworks houses, is another Northwest market. For a job in Denver, Northwest shipped 963 loads of 60-foot length, 110" O.D. pipe. Adcox recalls that many people remember the huge pipe, one piece per truck. "It was over-length, over-width, and the trucks could operate only during the daylight hours on weekdays," he chuckles.

Original equipment manufacturers like Pierce, Tumac, and Irrigation Power (three large center-pivot manufacturers) use Northwest pipe for irrigation systems. This irrigation pipe is essentially cut to close tolerances, with basic specifications being 6 5/8" O.D. x 39 ft. 11/34" in length. Galvanized steel pipe for grain-spouting augers is another application, and here again, special lengths can be accommodated.

API pipe, manufactured under license by the petroleum institute, is used for gas-gathering lines and by gas utilities for municipalities. Sheet metal and blow-pipe fabricators purchase thin wall Northwest pipe for manufacture into fittings and for other uses. Coupler pipe of deep-drawing quality aluminum killed steel is desirable for its formability. Much of Northwest's business is handled on a direct-bid basis with contractors; however, the firm normally works through distributors.

Northwest Pipe also manufactures many orders of special design. The company can supply most types of end joints recognized by the industry. Pipe may be ordered bare, galvanized, coal-tar enamelled, or with special finishes. Northwest Pipe also manufacturers many special fittings—wyes, ells, tees, crosses, etc.—to facilitate one-source procurement for both the pipe and the various special elements required for many projects.

"Our scheme in steel pipe manufacture is definitely slanted toward light wall," Adcox explains. "We can't bump heads with the fully integrated mills for heavy wall. Since much of our cost is in the steel itself, we specialize in lighter

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wall pipe requiring less tonnage. We know our niche, and we operate within it."

Several pieces of machinery used by Northwest Pipe were developed by the plant engineer Jerry Walker, in collaboration with company president Ralph Elle. Three of the 5 spiral mills are of Northwest's own manufacture; and the ERW straight seam mills have been upgraded through new tooling design, larger welding units, and the use of in-line ultrasonic and annealing facilities.

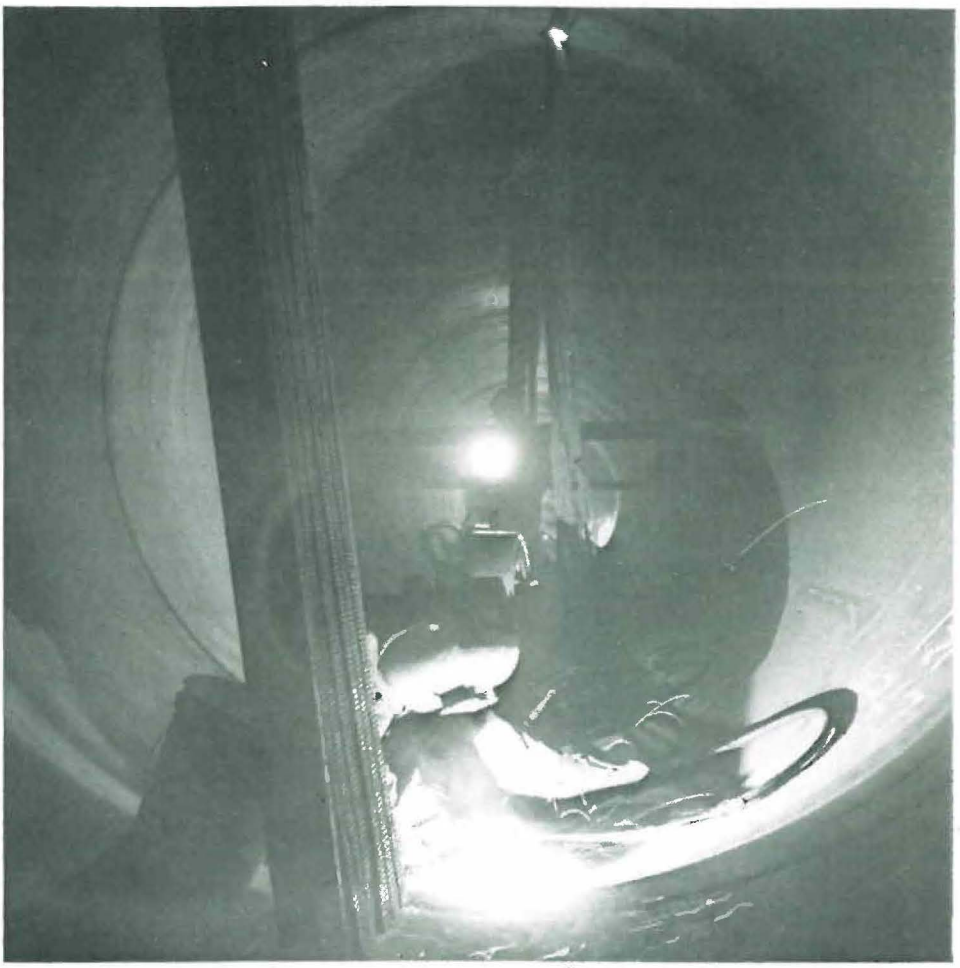
Patents are also held on inside mandrels used for hydrostatically testing large diameter pipe. The system utilizes a pipe within a pipe, with water introduced between the walls for testing, resulting in a substantial reduction of testing time. Another innovation is the design for circular cutting of ERW pipe on the fly, using a plasma torch.

Employees are encouraged to make recommedations and to provide input on equipment features they would like to have. And since they are the ones who operate the machinery on a day-to-day basis, workers sometimes have suggestions for improvements which can be implemented. The company acts on these suggestions when feasible.

The facilities for Northwest Pipe & Casing are located on two sites. The original plant, in Clackamas, Oregon, is situated on 50-odd acres. Facilities here include the company headquarters, manufacturing facilities, engineering offices, pipe yard, and quality control.

Also at the Clackamas location is an extensive coating facility. External coatings include coal tar enamel, asphalt, X-Tru coat, and fused epoxy. Internal coatings include cement mortar, coal tar enamel, T and O, and two-component epoxy.

Across town, at the North Portland Plant, the facilities purchased from Beall are used as a second manufacturing plant. Coating facilities are duplicated with the exception of X-Tru coat and



Welding inside 110" O.D. pipe. Daylight is at the end of the "tunnel."

Northwest Pipe & Casing, Clackamas Plant, September 1982, Photo courtesy of the Port of Portland.

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powdered epoxy. Together both plants under roof encompass a total of 625,000 square feet on approximately 83 acres.

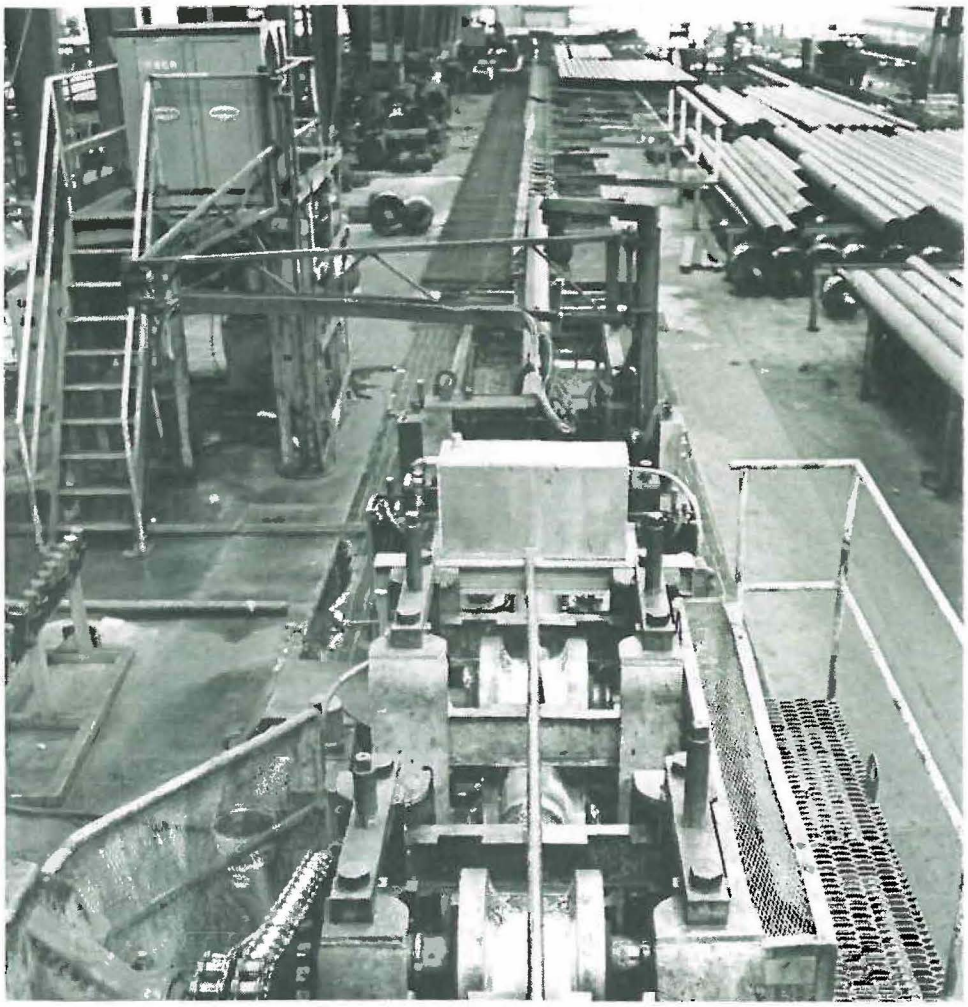
Five hundred feet away from the North Portland facility, the Port of Portland Terminal 4 Dock handles water shipping with berthing capabilities for large vessels. Northwest has supplied pipe for international projects in such diverse areas as Mexico, Saudi Arabia, and the Philippines.

On the wall opposite Herman Adcox's desk is a map of the United States. There is a duplicate of that map in the office of Northwest Pipe Sales Manager Virgil Vandenburg. The maps are used to visualize customers state by state, and calls are made to persons with whom they haven't talked recently. When sales are slow, you just can't sit around complaining. You have to do something about the situation.

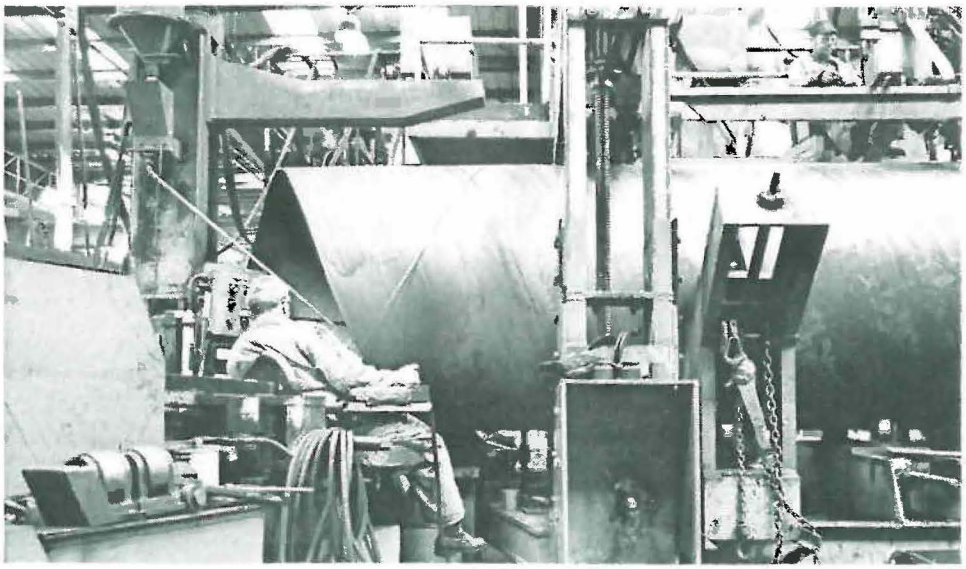
"I had done no on-the-road selling before I came with Northwest Pipe. When I was with the airlines, there were lots of air travel and many, many people problems. But having the chance to visit unfamiliar towns by car, to talk with new-found friends, stay in nice roadside hotels rather than airport hotels—that seemed like being on a company-paid vacation. I would go into a new town, cold, and ask myself, 'Who's gonna buy pipe in this town who doesn't know it?'

"We at Northwest Pipe & Casing truly believe in the importance of having satified customers," Adcox concludes. "We started a lot of people in business and have served them from the outset. This arrangement has been beneficial to everyone. People tend to remember when they are treated right."

This article was written following on-site research at Northwest Pipe & Casing, courtesy of Ralph Elle, Herman Adcox, and their staff. I thank them particularly for the opportunity to observe their company first-hand and to continue my education about the steel pipe industry. *-pfw-*



16" O.D. pipe mill, ERW. Pay-off tables. 12" O.D. pipe on mill.



Northwest Pipe spiral mill, one of five. Largest pipe made on this mill to date is 154" O.D. Pipe in the picture is 60" O.D. x 3/8" wall x 60' long; for Spirit Lake Project, Mount St. Helens, September 1982.

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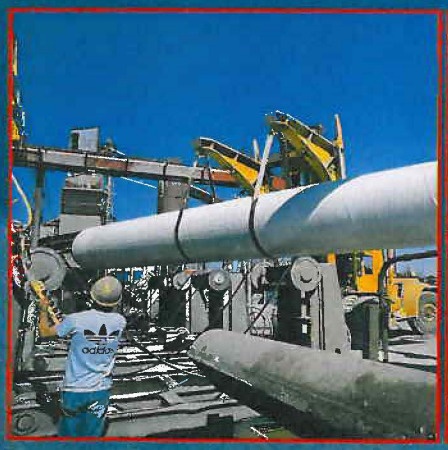


Introduction

Specializing in steel pipe since 1966, Northwest Pipe Company has earned a reputation as one of the nation's leading suppliers of welded steel pipe meeting the most demanding specifications.

The pages ahead will introduce you to some of the processes involved in the manufacture of steel pipe. A table is also included as a convenient reference in determining the approximate pipe wall thickness needed for your application.

Northwest Pipe Company offers the right combination of personnel and modern facilities to produce a wide variety of quality pipe products offered at a reasonable cost.

The most advanced pipe production techniques and equipment are utilized, some of which have been specially designed by Northwest Pipe Company engineers to meet a wide variety of job requirements.

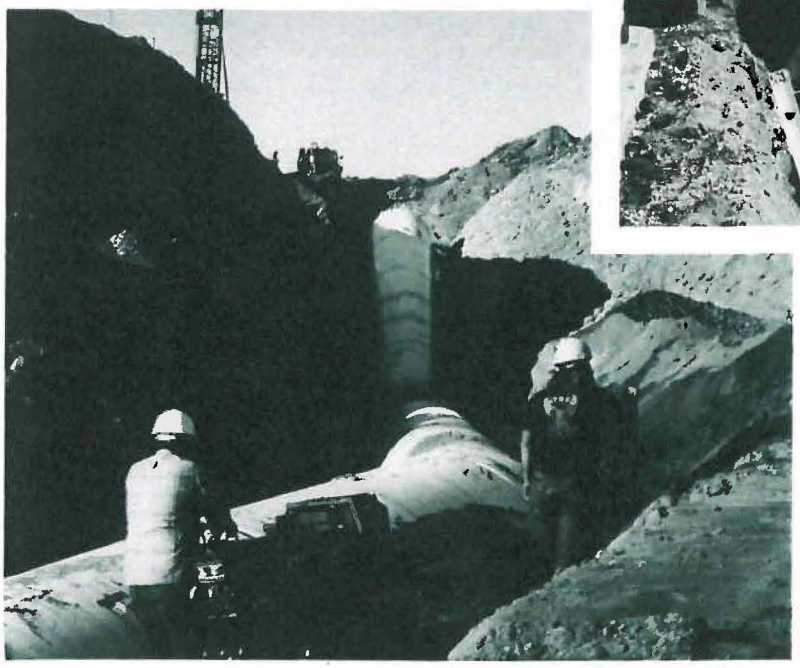
You'll find the answer to your installation needs at Northwest Pipe Company. We're ready to serve you and save you money on shipping and handling. We have manufacturing plants conveniently located in Portland, Oregon; Atchison, Kansas; and Adelanto, California.

Northwest Pipe Company is the supplier of steel pipe products to some of the most basic and vital industries in the American economy, such as water and fire protection, agriculture production, lumber and plywood manufacture, hydroelectric penstocks, and a growing number of other applications.

We welcome the opportunity to discuss your requirements.

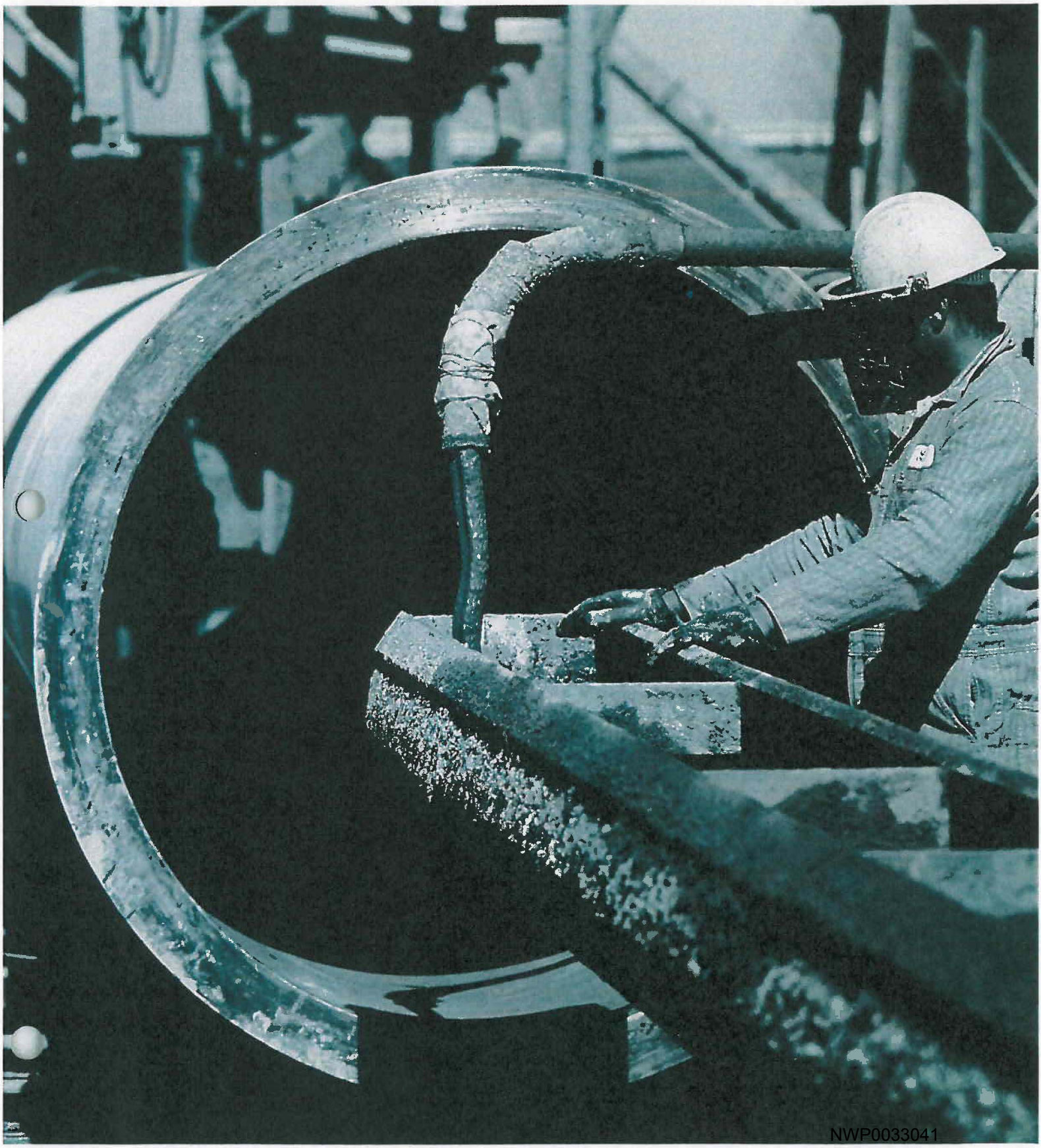
Transporting 42" diameter, cement-lined and -coated pipe to the ditch

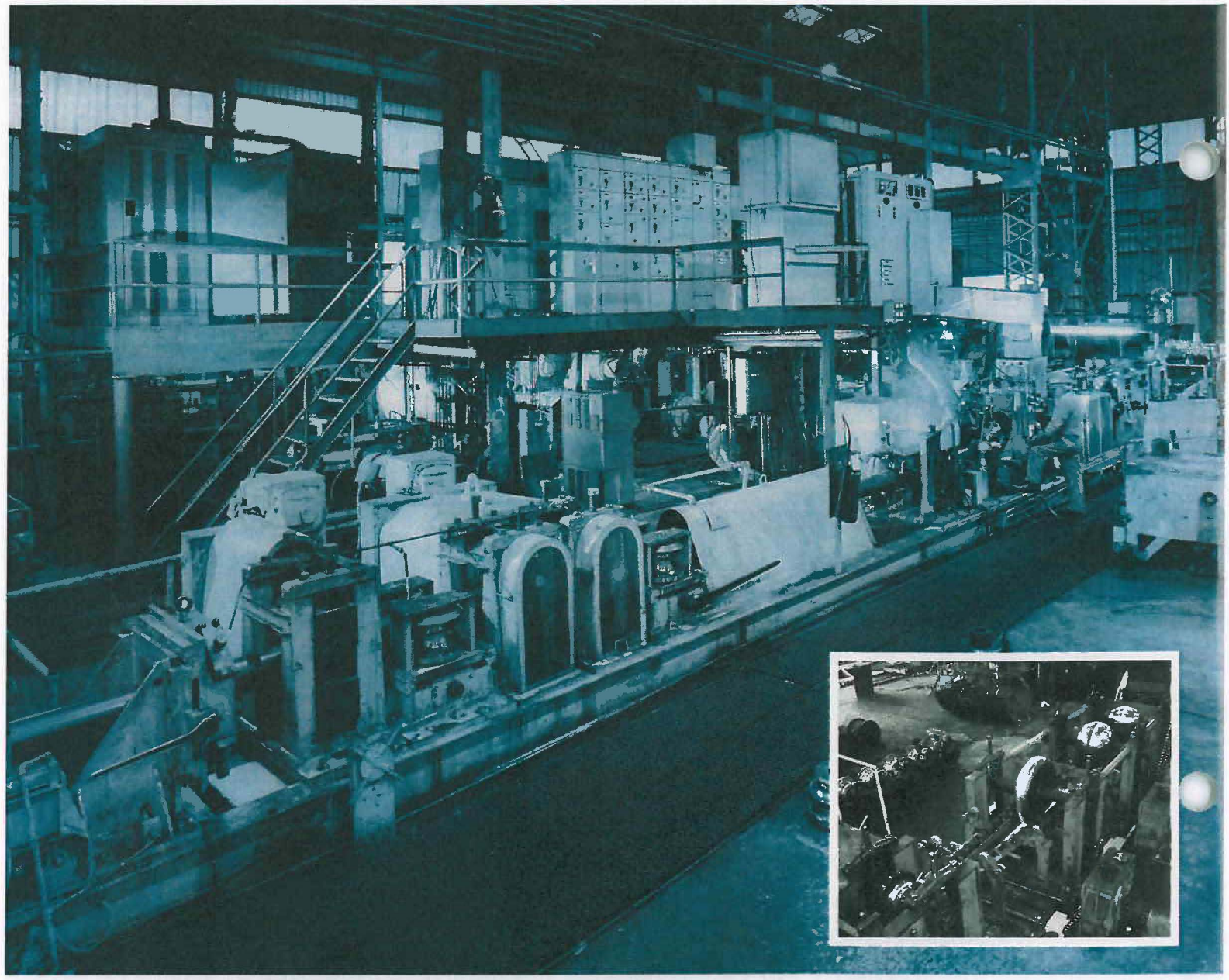
96" diameter, tape-coated pipe in Roseville, California

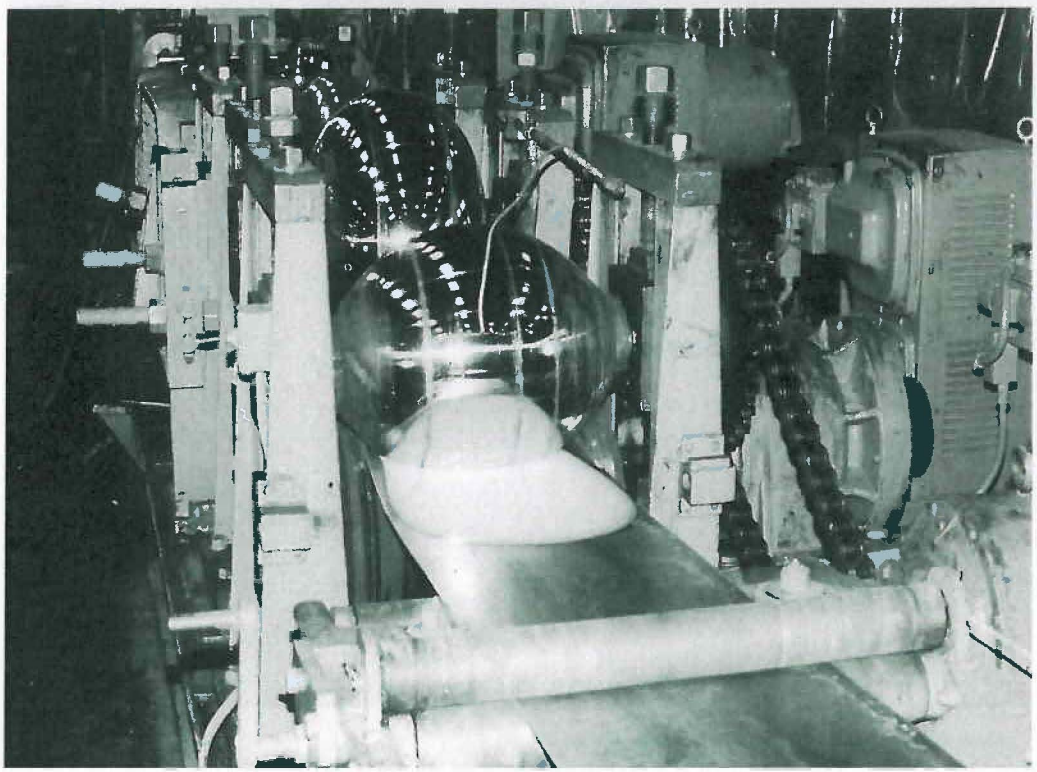


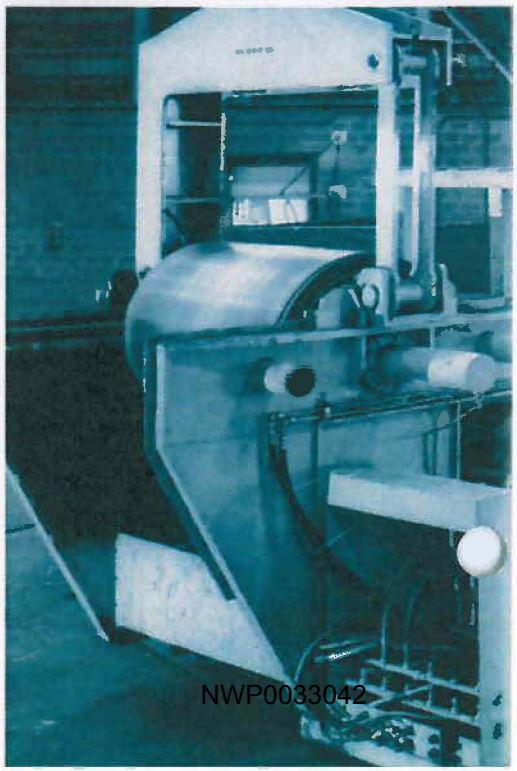
60" steel pipe in the process of cement mortar lining

Northwest Pipe Company









NWP0033042

Manufacturing

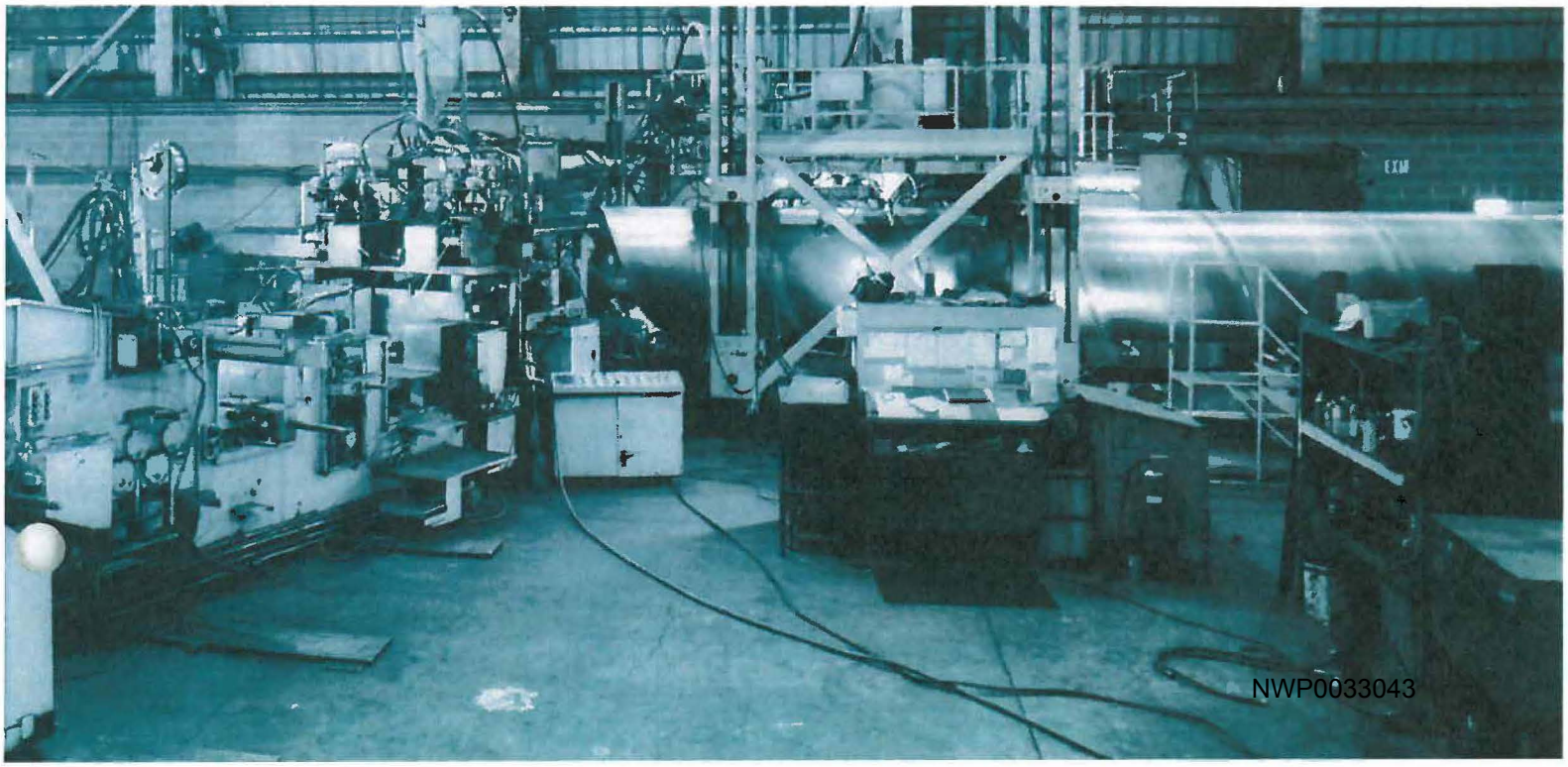
Northwest Pipe Company

ERW STRAIGHT SEAM PIPE

Northwest Pipe Company manufactures straight seam ERW carbon steel pipe in sizes 3" through 16" in wall thickness ranging from 0.063" through 0.250". The ERW straight seam pipe mill (pictured left) is used to produce pipe by gradually forming the steel sheet over a series of rolls until it is round. The seam is welded by a process called "electric resistance welding" (ERW). This process applies heat and pressure to form a flawless weld, which becomes an integral part of the pipe as it is produced. The pipe is cut to length, most commonly 40 feet. The pipe is then hydrostatically tested in accordance with the specifications. After testing and inspection, the pipe is ready for coating, shipping, or other specified fabrication.

SPIRALLY WELDED PIPE

Northwest Pipe Company also manufactures spirally welded steel pipe (pictured below) in sizes 17" through 155" OD and wall thicknesses of 0.105" through 0.750". Spiral weld steel pipe is manufactured from steel coils formed helically into cylinders. The cylinders are welded as they are formed, utilizing the double submerged arc process, accomplishing 100% penetration welds and forming a flawless seam that becomes an integral part of the pipe. This welding process ensures optimum product integrity and strength. After welding, the piece of pipe is cut to the desired length, usually from 40 to 60 feet. The finished pipe is then hydrostatically pressure tested to 75% of its specified yield strength or to the appropriate specification or customer requirement. Upon completion of testing and inspection, the pipe is ready for coating, shipping, or other fabrication processes as specified.



Coatings/Linings

An assortment of coatings and linings are offered by Northwest Pipe Company.

The primary function of protective pipe coatings is to prevent corrosion. Linings provide for the maintenance of design flows as well as corrosion prevention.

Your Northwest Pipe Company representative can describe several coating and lining systems that are available to meet a wide range of applications and working environments.

COAL TAR ENAMEL INTERIOR LINING AND COATING

Specifications: AWWA C-203.

CLEANING AND BLASTING

All surfaces to be coated are cleaned by blasting to an appearance between SSPC-SP6 and SSPC-SP10.

PRIMING

Immediately after blasting, the pipe receives a machine-applied primer coating. The primer coating is applied as recommended by the manufacturer. When complete, the coating is uniform and free of sags, runs, and bare spots.

COAL TAR LINING APPLICATION

After the primer drying process, the pipe receives a 3/32" (0.093" ± 0.031") thick coal tar enamel interior lining, which is centrifugally applied. Linings are consistent, smooth and uniform.

COAL TAR ENAMEL COATING APPLICATION

After the primer drying process, the exterior coal tar system is applied by pouring hot coal tar over the surface of the rotated pipe. The coal tar coating has a uniform thickness of 3/32" (± 0.031") and is smooth and free of voids.

Simultaneous to the application of hot coal tar, an outer wrap is spirally applied, bonding to the hot coal tar.

The resulting system is comprised of blasting, priming, coal tar enamel (0.093" ± 0.031"), bonded outer wrap, and a finish coat of kraft paper or whitewash at manufacturer's option.

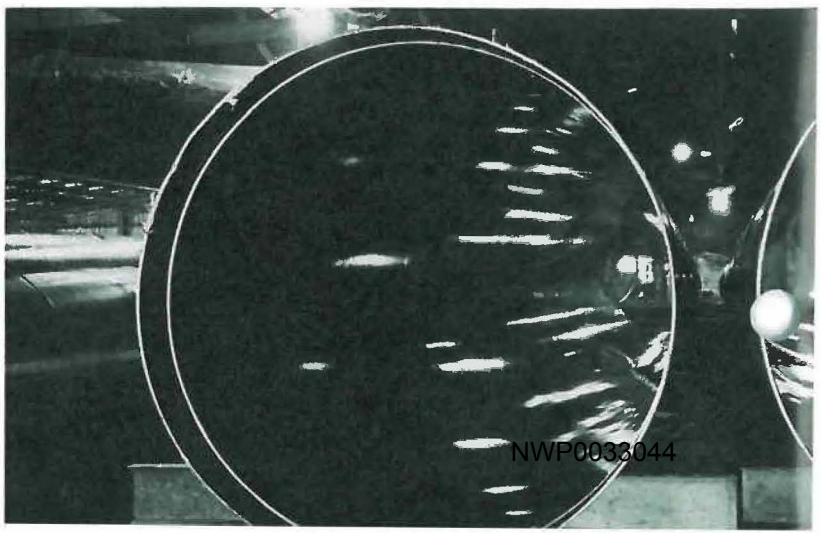
TESTING

All coal tar enamel coatings are electrically inspected at the plant before shipment. The test will impress a maximum of 15,000 volts to determine voids. Exact voltage may be determined in AWWA C-203.

Advantages of coal tar enamel are:

- Long and successful record of performance
- High electrical resistance
- Imperviousness to water
- Stability and chemical inertness
- Good mechanical strength
- Ease of installation
- Reasonable cost
- Flexibility
- Prevention of corrosion
- Sustained high hydraulic flow capacity
- Resistance to shipping and handling damage
- Resistance to soil stress
- Reduced maintenance costs

Coal tar enamel lined pipe



Northwest Pipe Company

TAPE EXTERIOR COATING SYSTEM

Specifications: AWWA C-214.

The tape system is comprised of machine blasting; priming; application of a prefabricated, cold-applied, corrosion-preventive inner layer tape; and application of a mechanical protective outer layer tape. Tape coating is available in 50-mil and 80-mil systems.

BLASTING

All surfaces to be coated are cleaned by blasting to an appearance between SSPC-SP6 and SSPC-SP10.

PRIMING

Immediately after blasting, the pipe receives a machine-applied primer coating. The primer coating is applied as recommended by the manufacturer.

TAPE APPLICATION

Immediately following the blasting and priming operations, the inner wrap is applied. The inner wrap is spirally applied with a 1"-minimum overlap and as recommended by the manufacturer.

Simultaneous to the inner wrap application, the outer wrap is also spirally applied with a 1"-minimum overlap.

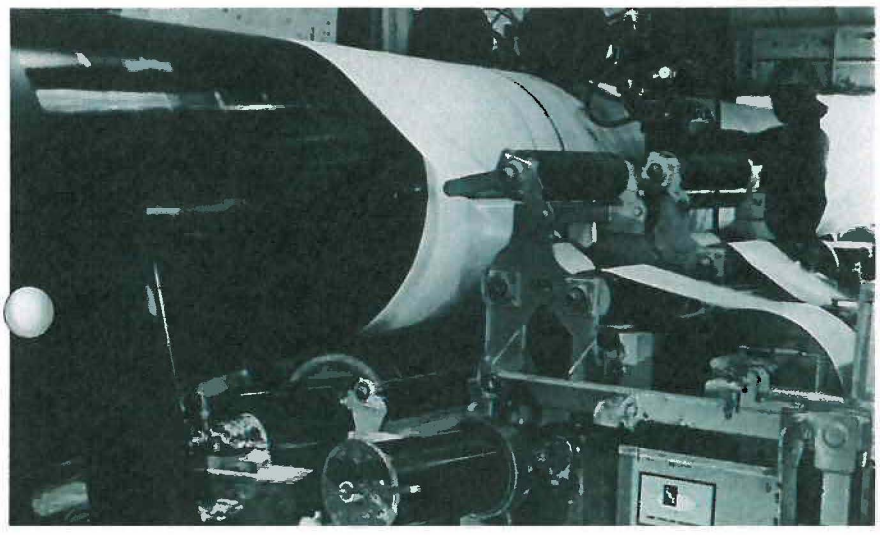
TESTING

The inner wrap of each coated pipe receives electrical testing to determine voids in the coating. The detector will impress a minimum of 6,000 volts. The pipe is further tested to meet all specification requirements.

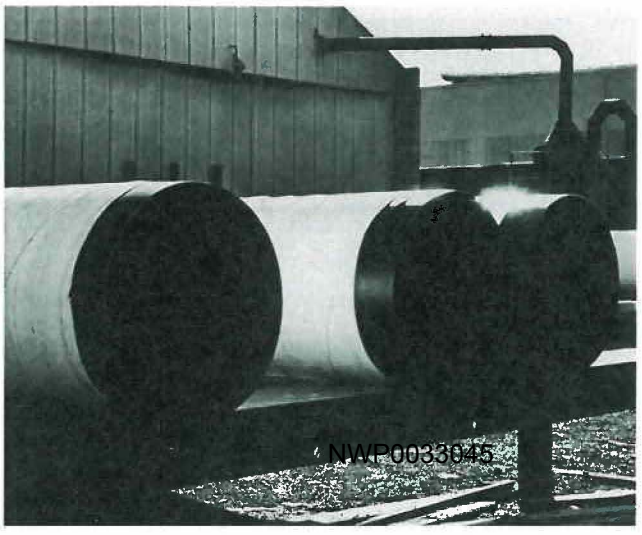
Advantages of tape coating are:

- Long and successful record of performance
- High electrical resistance
- Imperviousness to water
- Stability and chemical inertness
- Good mechanical strength
- Ease of installation
- Reasonable cost
- Flexibility
- Prevention of corrosion
- Resistance to shipping and handling damage
- Resistance to soil stress
- Reduced maintenance costs

Application of tape coating system



Finished tape coated pipe



Coatings/Linings

CEMENT MORTAR LINING & COATING

Specifications: AWWA C-205.

INTERIOR LINING

The cement mortar lining system is applied by spinning the pipe and centrifugally applying the mortar. The lining thickness ranges from 0.250" to 0.750", depending on the diameter of the pipe.

EXTERIOR COATING

The cement mortar coating system is applied by placing the cylinder on a lathe-type spinner and pneumatically applying the mortar to the specified thickness.

Simultaneous to the mortar application, a reinforcement of either spiral wire, wire fabric, or wire mesh is applied to the middle third of the coating with a minimum coating over the wire of 0.188".

CURING OF LINING & COATING

Immediately after completion of coating and lining, the pipe sections will require curing. Two methods of curing are available: accelerated steam curing and moist curing. By using the accelerated steam curing method, pipe will be ready to ship not sooner than 18 hours after curing has commenced. If the moist curing method is used, a minimum of four days are required before shipping can begin, depending upon temperature conditions. Both curing methods provide a high-quality coating.

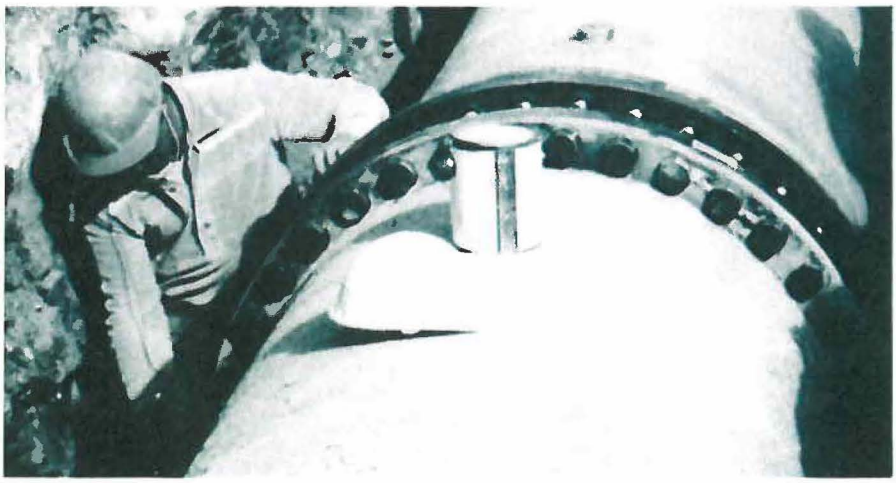
Advantages of cement mortar lining and coating are:

- Long and successful record of performance
- Good mechanical strength
- Ease of installation
- Reasonable cost
- Prevention of corrosion
- Sustained high hydraulic flow capacity
- Resistance to shipping and handling damage
- Reduced maintenance costs

OTHER TYPES OF COATINGS

Other available coatings include coal tar epoxy, epoxy paint, and a variety of specialized coating systems. For coating systems to meet your specific needs, please contact your Northwest Pipe Company sales representative.

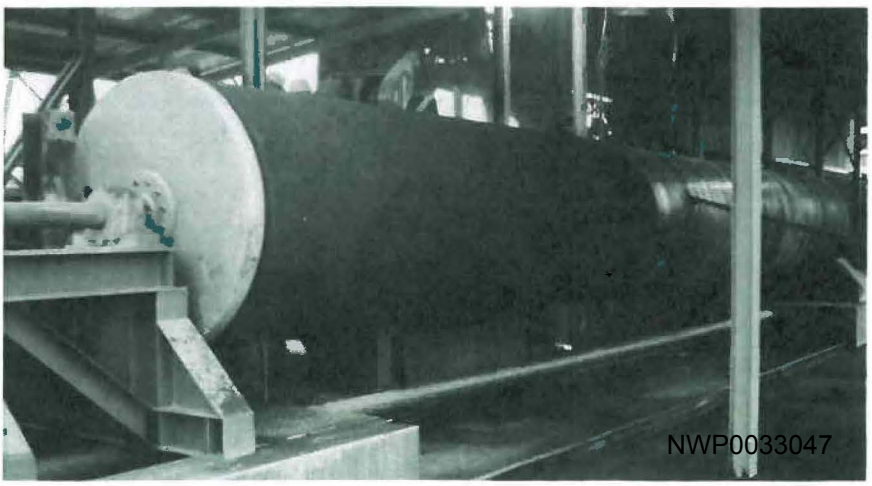
Applying corrosion protective joint material on flanged joint



Installing 54" liner pipe

Northwest Pipe Company

30" steel pipe in the process of cement mortar lining



60" steel pipe in the process of cement mortar coating

NWP0033047

Pipe Joints

Northwest Pipe Company manufactures AWWA approved end preparations to meet your every need.

Welded Joints:

Bell and Spigot Lap Weld Joints:
By expanding one end of the pipe, a joint is formed allowing the pipe to be welded together by a simple fillet weld. On small-diameter pipe, this could be a single outside fillet weld. On larger-diameter pipe, an inside or outside fillet weld may be desirable.

Single-V-Butt Welded Joints:

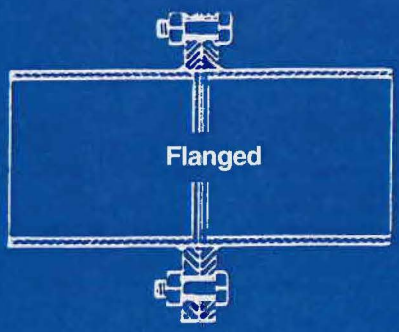
By beveling the ends of the pipe, a single V-Butt welded joint can be formed that will develop the full strength of the pipe. This type of welded joint is particularly adaptable to heavier-wall steel pipe and to field-cut pipe that cannot be readily belled in the field.

Mechanical Couplings:

(victaulic type)
Grooved or shoulder-type couplings require either a cut groove or, in the case of lighter-wall pipe, a rolled groove end.
Northwest Pipe Company can supply the "rolled-in" grooved pipe as well as standard-weight grooved pipe ends welded on to nominal pipe sizes as well as O.D. pipe sizes, thereby giving a cut grooved end.

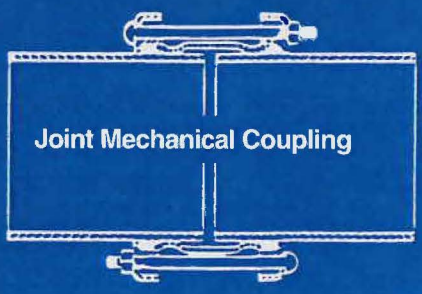
O-Ring Bell and Spigot Rubber Gasket Joints:

These are the most economical field joints. They can be assembled in minutes and will accommodate some deflection at the joints and still provide a positive seal for internal pressure. The joint deflection table gives the allowable joint deflection on Northwest Pipe Company joints for sizes 4" through 60".



Flanged Joints:

Normally, flanges are welded onto the pipe for connecting to flanged gate valves, meters, etc. Pipe flanges must be specified by thickness, outside diameter of the flange, diameter of the bolt circle as well as bolt hole size, and number of bolt holes. Flanged joints do not allow for any misalignment of the pipe.



Mechanical Couplings:

Sleeve-type mechanical couplings require no special end preparations, allow for pipe expansion, and give a flexible joint as with the O-ring rubber gasket joint. This type of joint is especially useful for field joints and for replacing damaged sections of pipe in an existing line.

NWP0033048

Northwest Pipe Company

JOINT DEFLECTION

JOINT DEFLECTION TABLE (O-RING JOINTS)			
PIPE DIAMETER	ALLOWABLE JOINT DEFLECTION	OFFSET IN 40'	OFFSET IN 48'
4"	5.00°	3'-5"	4'-2"
6"	5.00°	3'-5"	4'-2"
8"	5.00°	3'-5"	4'-2"
10"	4.21°	2'-11"	3'-6"
12"	3.49°	2'-5"	2'-11"
14"	3.00°	2'-1"	2'-6"
16"	2.64°	1'-10"	2'-2"
18"	3.11°	2'-2"	2'-7"
20"	2.80°	1'-11"	2'-4"
22"	2.55°	1'-9"	2'-1"
24"	2.34°	1'-7"	1'-11"
26"	2.17°	1'-6"	1'-9"
28"	2.01°	1'-4"	1'-8"
30"	1.88°	1'-3"	1'-6"
32"	1.76°	1'-2"	1'-5"
34"	1.66°	1'-1"	1'-4"
36"	1.57°	1'-1"	1'-3"
38"	1.49°	1'-0"	1'-3"
40"	1.41°	1'-0"	1'-2"
42"	1.35°	0'-11"	1'-1"
48"	1.18°	0'-10"	1'-0"
54"	1.05°	0'-8"	0'-10"
60"	0.94°	0'-8"	0'-9"

NOTES:

1. The angular deflection at bell and spigot joints shall in no case exceed 5 degrees.
2. Allowable joint deflections for pipe sizes not shown are available upon request. For the purpose of reducing the angular deflection to joints, and for closure sections, pipe sections of shorter than standard lengths should be used.
3. The Joint Deflection Table above is based on pulling the joints 0.750" on one side for pipe sizes through 16" and 1" on pipe sizes larger than 16" diameter.
4. Joint deflection per above table is allowed for pressure ranges through 300 psi.
5. Joints are always to be assembled in straight alignment then moved to obtain the necessary deflection.
6. Pipe is to have sufficient cover to restrain movement from unbalanced forces.

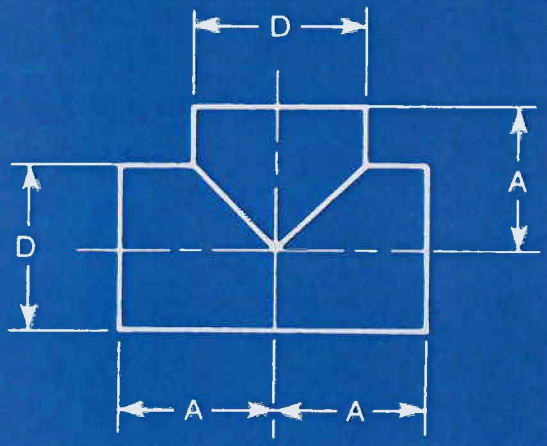
JOINT DEFLECTION (WELD BELL JOINTS)

The Joint Deflection Table may be utilized for normal weld bell deflections. Greater deflection can be accomplished with deep bells or by using mitered spigots or bells.

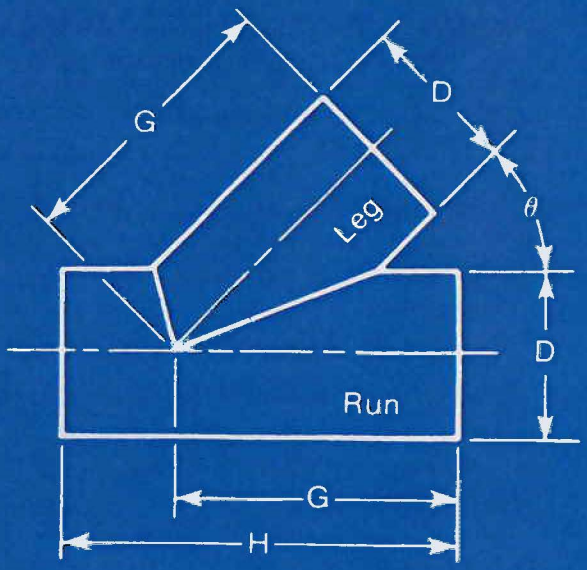
Fabrication

The Northwest Pipe Company engineering department offers qualified technical assistance through all phases of project development. From preparation of shop drawings to fabrication supervision, Northwest Pipe Company personnel work hard to see that every project requirement is met.

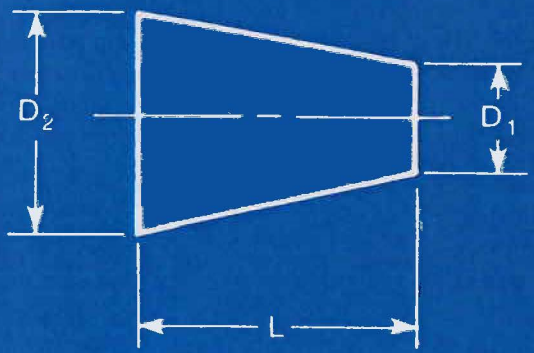
Northwest Pipe Company offers a large choice of custom fabrication, ranging from elbows, flanges, and tees to ring girders and bifurcations.



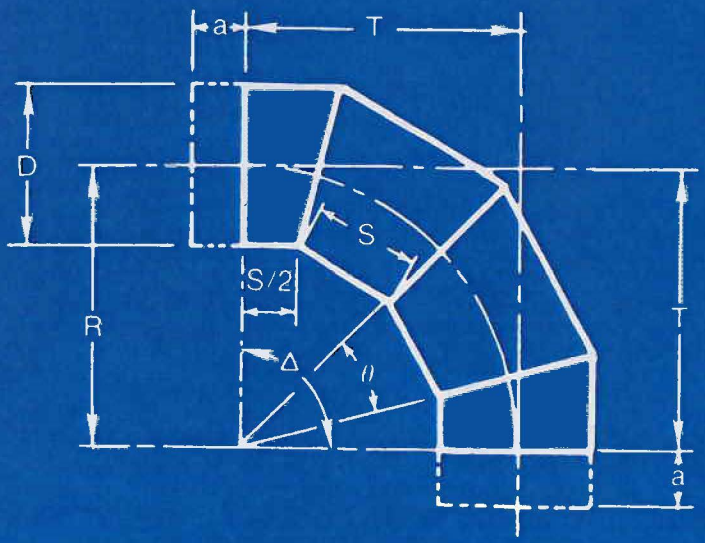
TEE



LATERAL



REDUCER



FOUR-PIECE ELBOW (45-90°)

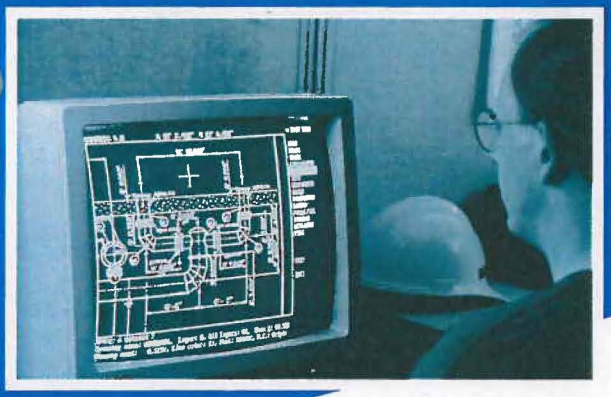
NWP0033050

Project Services

Northwest Pipe Company

Northwest Pipe Company offers a wide range of project services. For the contractor, we provide layout and detail drawings for submittal to the engineer. Our engineering staff is equipped with computerized layout systems that ensure timely and accurate layout work.

Each project is assigned to a project manager, who will oversee the entire project through completion. Northwest Pipe Company will also provide an "on-the-job-site" person to give assistance in project start-up.



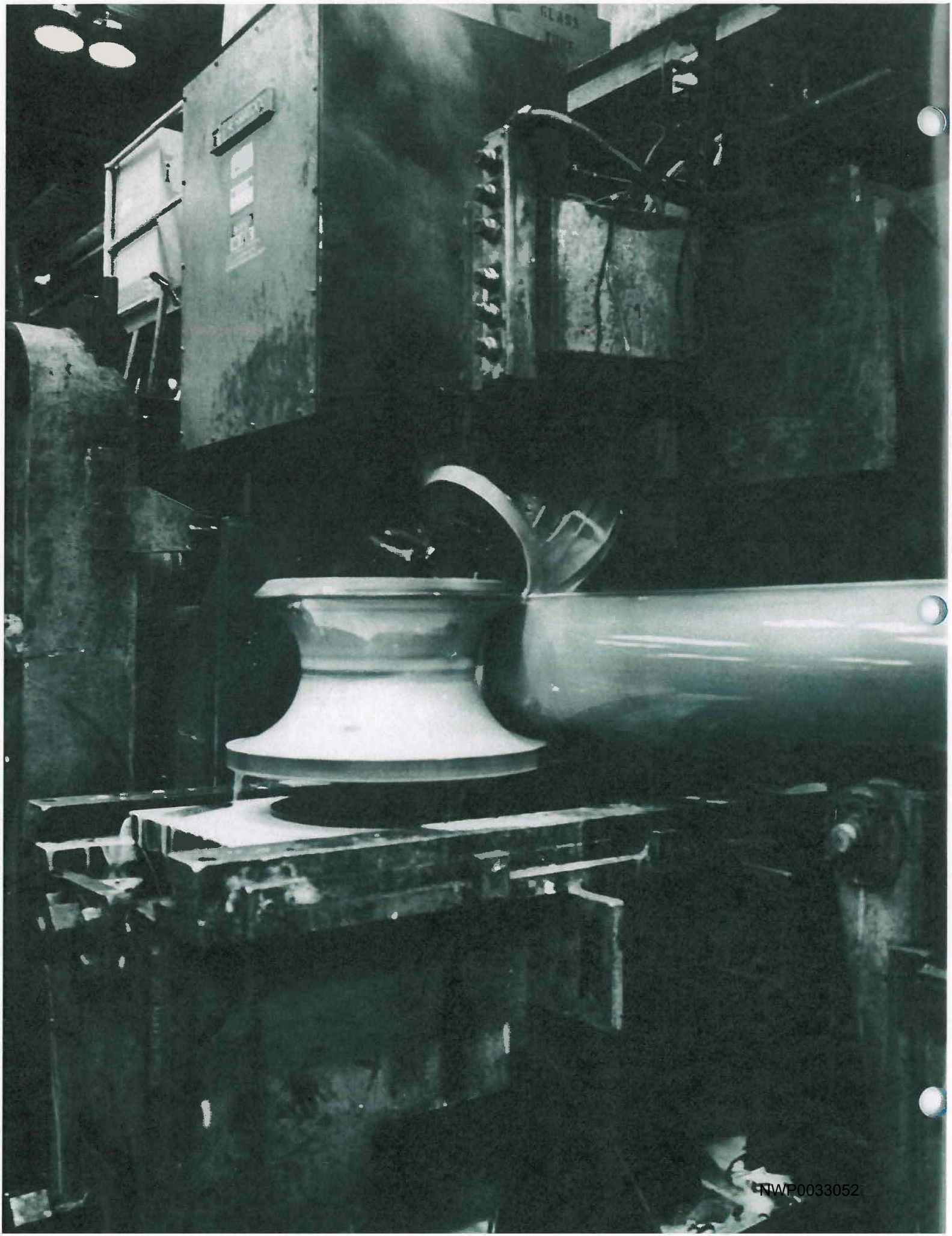
PIPELINE LAYOUT CALCULATIONS

PAGE : 5
DATE : 7/26/95
BY : IND
PROJECT ID : 2676ID.FIL

PROJECT
KALOOR/HUMPBACK WATERMAIN
GREATER VICTORIA WATER DISTRICT

MARK NO	PIPE DESCRIPTION	LEN (NLL) (ALL) (HLL)	DEF (VERT) (HOR) (COM)	SLOPE (DEG) (DOS) (TAN)	PIPE SPIG STATION	SPIG INV ELEV
	CONTINUED FROM PAGE 4(P# 372)				-.0403 0+12.99	489.04
373	2 CUT ELBOW 48.750"X.375" EL(2/W) @20WBA XWS SPECIAL ELBOW DESIGN DEG+27.12336 RAD=170.625 TAN= 41.158 (IN) TPL=20.000(FT)	8.27 8.35 8.34 11.83 11.83 11.83	.00 .00 2.16 -27.05 27.12	-2.3089 .0002 -.0402 -.1492 1.0000 -.0026	0+21.33 0+33.16	488.71 488.55
	48.750X.375" STD @ 50' WBA X WS	49.75 49.75 49.74		-.1492 1.000 -.0026	0+82.91	488.55

NWP0033051


NWP0033052

Selection of Wall Thickness

Northwest Pipe Company

It is important to note that steel is available in any thickness required. It is not necessary to order steel pipe in common sizes, i.e., 0.188", 0.250", 0.313", etc.

The designer can determine a minimum wall thickness after evaluation of internal pressure, external loads, and all other design considerations. Several design manuals are available, the most widely recognized for steel pipe being the AWWA M-11, or the Welded Steel Pipe Manual published by the American Iron and Steel Institute.

NOTE: The following table of working pressures and weights is offered as a general guide only. Figures are based on the most current data and industry practice; however, Northwest Pipe Company cannot assume responsibility for accuracy or any liabilities resulting from use of these figures. To obtain information on sizes and specifications for your job, call your Northwest Pipe Company representative.

Calculation of Minimum Wall Thickness

(Barlow Hoop Stress Formula) $t = \frac{PD}{2S}$

Note that this equation allows a safety factor of 2. Pipe is commonly hydrostatically tested in the plant to 1.5 times the working pressure.

t = Thickness
P = Working Pressure (PSI)
D = Outside Diameter (inches)
S = Design stress taken as 50% of the specified minimum yield strength of selected steel (PSI)

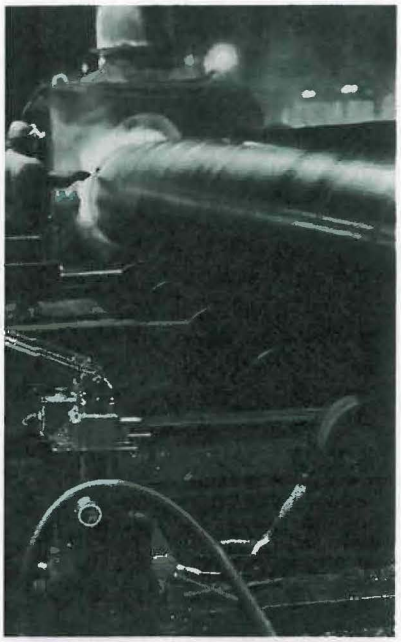
TABLE 1

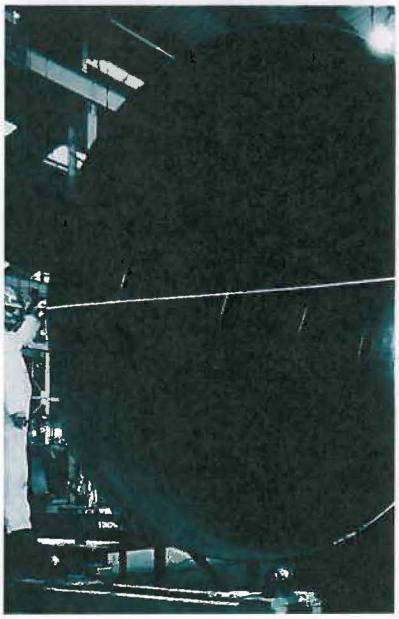
STRAIGHT SEAM PIPE

3"-16" OUTSIDE DIAMETER • ELECTRIC RESISTANCE WELDED

PIPE O.D. INCHES	WALL THICKNESS INCHES	PIPE WEIGHT LBS./L.F.	WORKING PRESSURE MINIMUM YIELD 36,000 PSI	WORKING PRESSURE MINIMUM YIELD 42,000 PSI
3"	0.0747	2.3	896	1046
	0.1046	3.2	1255	1464
	0.1345	4.1	1614	1883
3.5"	0.0747	2.7	768	896
	0.1046	3.8	1076	1255
	0.1345	4.8	1383	1614
4"	0.0747	3.1	672	784
	0.1046	4.4	941	1098
	0.1345	5.6	1211	1412
	0.1875	7.6	1688	1969
4.5"	0.0747	3.5	598	697
	0.1046	4.9	837	976
	0.1345	6.3	1076	1255
	0.1875	8.6	1500	1750

NWP0033056





Selection of Wall Thickness

STRAIGHT SEAM PIPE

3"- 16" OUTSIDE DIAMETER • ELECTRIC RESISTANCE WELDED

PIPE O.D. INCHES	WALL THICKNESS INCHES	PIPE WEIGHT LBS./L.F.	WORKING PRESSURE MINIMUM YIELD 36,000 PSI	WORKING PRESSURE MINIMUM YIELD 42,000 PSI
5"	0.0747	3.9	538	627
	0.1046	5.5	753	879
	0.1345	7.0	968	1130
	0.1875	9.6	1350	1575
6"	0.0747	4.7	448	523
	0.1046	6.6	628	732
	0.1345	8.4	807	942
	0.1875	11.7	1125	1313
6.625"	0.0747	5.2	406	474
	0.1046	7.3	568	663
	0.1345	9.3	731	853
	0.1875	12.9	1019	1189
	0.2500	17.0	1358	1585
7"	0.0747	5.5	384	448
	0.1046	7.7	538	628
	0. 1345	9.9	692	807
	0.1875	13.7	964	1125
8"	0.0747	6.3	336	392
	0.1046	8.8	471	549
	0.1345	11.3	605	706
	0.1875	15.7	844	984
8.625"	0.1046	9.5	437	509
	0.1345	12.2	561	655
	0.1875	16.9	783	913
	0.2500	22.4	1043	1217
10"	0.1046	11.1	377	439
	0.1345	14.2	484	565
	0.1875	19.7	675	788
	0.2500	26.1	900	1050
10.75"	0.1046	11.9	350	409
	0.1345	15.3	450	525
	0.1875	21.2	628	733
	0.2500	28.1	837	977
12"	0.1046	13.3	314	366
	0.1345	17.1	404	471
	0.1875	23.7	563	656
	0.2500	31.4	750	875

Northwest Pipe Company

STRAIGHT SEAM PIPE

3"- 16" OUTSIDE DIAMETER • ELECTRIC RESISTANCE WELDED

PIPE O.D. INCHES	WALL THICKNESS INCHES	PIPE WEIGHT LBS./L.F.	WORKING PRESSURE MINIMUM YIELD 36,000 PSI	WORKING PRESSURE MINIMUM YIELD 42,000 PSI
12.75"	0.1046	14.1	295	345
	0.1345	18.1	380	443
	0.1875	25.2	529	618
	0.2500	33.4	706	824
14"	0.1046	15.5	269	314
	0.1345	19.9	346	404
	0.1875	27.7	482	563
	0.2500	36.7	643	750
16"	0.1046	17.8	235	275
	0.1345	22.8	303	353
	0.1875	31.7	422	492
	0.2500	42.1	563	656

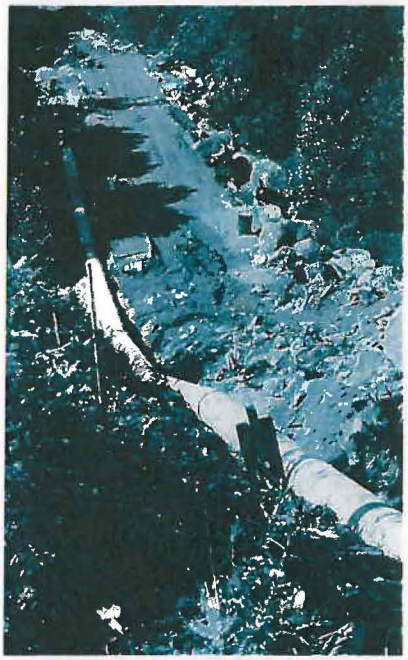
SPIRAL WELD PIPE

17"- 144" OUTSIDE DIAMETER • SUBMERGED ARC WELD

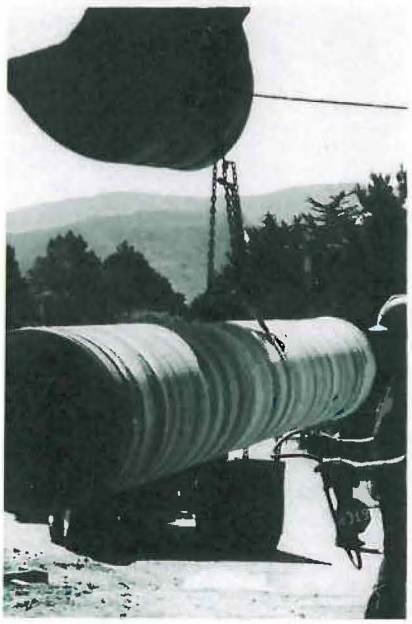
PIPE O.D. INCHES	WALL THICKNESS INCHES	PIPE WEIGHT LBS./L.F.	WORKING PRESSURE MINIMUM YIELD 36,000 PSI	WORKING PRESSURE MINIMUM YIELD 42,000 PSI
18"	0.1046	20.0	209	244
	0.1345	25.7	269	314
	0.1875	35.7	375	438
	0.2500	47.4	500	583
20"	0.1046	22.2	188	220
	0.1345	28.6	242	282
	0.1875	39.7	338	394
	0.2500	52.8	450	525
22"	0.1046	24.5	171	200
	0.1345	31.4	220	257
	0.1875	43.7	307	358
	0.2500	58.1	409	477
24"	0.1046	26.7	157	183
	0.1345	34.3	202	235
	0.1875	47.7	281	328
	0.2500	63.5	375	438
26"	0.1046	29.0	145	169
	0.1345	37.2	186	217
	0.1875	51.7	260	303
	0.2500	68.8	346	404

NWP00330

Assembling a 30" O-Ring joint.



Ready to backfill a 48" diameter tape coated penstock in California.



Selection of Wall Thickness

SPIRAL WELD PIPE

17"- 144" OUTSIDE DIAMETER • SUBMERGED ARC WELD

PIPE O.D. INCHES	WALL THICKNESS INCHES	PIPE WEIGHT LBS./L.F.	WORKING PRESSURE MINIMUM YIELD 36,000 PSI	WORKING PRESSURE MINIMUM YIELD 42,000 PSI
28"	0.1046	31.2	134	157
	0.1345	40.1	173	202
	0.1875	55.7	241	281
	0.2500	74.2	321	375
30"	0.1046	33.4	126	146
	0.1345	42.9	161	188
	0.1875	59.8	225	263
	0.2500	79.5	300	350
32"	0.1046	35.7	118	137
	0.1345	45.8	151	177
	0.1875	63.8	211	246
	0.2500	84.9	281	328
34"	0.1046	37.9	111	129
	0.1345	48.7	142	166
	0.1875	67.8	199	232
	0.2500	90.2	265	309
36"	0.1345	51.6	135	157
	0.1875	71.8	188	219
	0.2500	95.5	250	292

WALL THICKNESS

CALCULATED BY PRESSURE CLASS

PIPE O.D. INCHES	PRESSURE CLASS PSI	36 KSI YIELD STEEL	PIPE WEIGHT LBS./L.F.	42 KSI YIELD STEEL	PIPE WEIGHT LBS./L.F.
18"	200	0.100	19.1	—	—
	250	0.125	23.9	0.107	20.5
	300	0.150	28.6	0.129	24.6
	400	0.200	38.1	0.171	32.7
	500	0.250	47.4	0.214	40.7
	600	0.300	56.8	0.257	48.8
	700	0.350	66.0	0.300	56.8
	800	—	—	0.343	64.7
20"	200	0.111	23.6	0.095	20.3
	250	0.139	29.5	0.119	25.3
	300	0.167	35.3	0.143	30.3
	400	0.222	47.0	0.191	40.3
	500	0.278	58.6	0.238	50.3
	600	0.333	70.1	0.286	60.2
	700	0.389	81.5	0.333	70.1
	800	—	—	0.381	79.9

NWP0033056

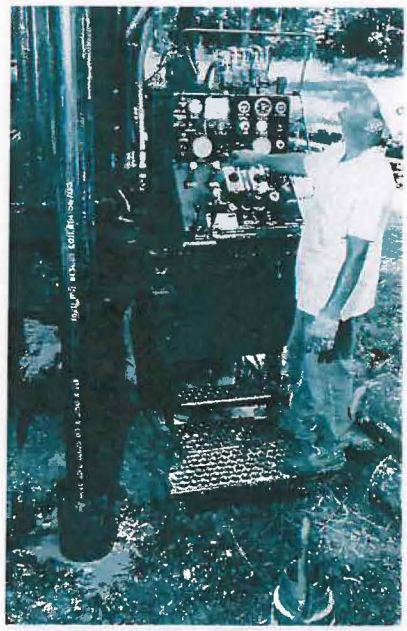
Northwest Pipe Company

WALL THICKNESS

CALCULATED BY PRESSURE CLASS

PIPE O.D. INCHES	PRESSURE CLASS PSI	36 KSI YIELD STEEL	PIPE WEIGHT LBS./L.F.	42 KSI YIELD STEEL	PIPE WEIGHT LBS./L.F.
22"	150	0.092	21.5	—	—
	200	0.122	28.6	0.105	24.5
	250	0.153	35.7	0.131	30.6
	300	0.183	42.8	0.157	36.7
	400	0.244	56.8	0.210	48.8
	500	0.306	70.9	0.262	60.9
	600	0.367	84.8	0.314	72.9
	700	—	—	0.367	84.8
24"	150	0.100	25.5	—	—
	200	0.133	34.0	0.114	29.2
	250	0.167	42.5	0.143	36.4
	300	0.200	50.9	0.171	43.7
	400	0.267	67.7	0.229	58.1
	500	0.333	84.3	0.286	72.4
	600	0.400	100.9	0.343	86.7
	700	0.467	117.4	0.400	100.9
	800	—	—	0.457	115.1
26"	150	0.108	30.0	0.093	25.7
	200	0.144	39.9	0.124	34.2
	250	0.181	49.8	0.155	42.8
	300	0.217	59.7	0.186	51.2
	400	0.289	79.4	0.248	68.2
	500	0.361	99.0	0.310	85.0
	600	0.433	118.4	0.371	101.8
	700	0.506	137.8	0.433	118.4
	800	—	—	0.495	135.0
28"	125	0.097	29.0	—	—
	150	0.117	34.8	0.100	29.8
	200	0.156	46.3	0.133	39.7
	250	0.194	57.8	0.167	49.6
	300	0.233	69.3	0.200	59.4
	400	0.311	92.1	0.267	79.1
	500	0.389	114.8	0.333	98.6
	600	0.467	137.4	0.400	118.0
	700	0.544	159.8	0.467	137.4
	800	—	—	0.533	156.6
30"	125	0.104	33.3	—	—
	150	0.125	39.9	0.107	34.2
	200	0.167	53.2	0.143	45.6
	250	0.208	66.3	0.179	56.9
	300	0.250	79.5	0.214	68.2
	400	0.333	105.7	0.286	90.8
	500	0.417	131.8	0.357	113.2
	600	0.500	157.7	0.429	135.5
	700	0.583	183.4	0.500	157.7
	800	—	—	0.571	179.8

NWP0033057



Water well drillers installing Northwest Pipe's "Well-Life"

Pipe installed in trench.

Selection of Wall Thickness

WALL THICKNESS

CALCULATED BY PRESSURE CLASS

PIPE O.D. INCHES	PRESSURE CLASS PSI	36 KSI YIELD STEEL	PIPE WEIGHT LBS./L.F.	42 KSI YIELD STEEL	PIPE WEIGHT LBS./L.F.
32"	125	0.111	37.9	—	—
	150	0.133	45.4	0.114	39.0
	200	0.179	60.5	0.152	51.9
	250	0.222	75.5	0.191	64.8
	300	0.267	90.5	0.229	77.6
	400	0.356	120.3	0.305	103.3
	500	0.444	149.9	0.381	128.8
	600	0.533	179.4	0.457	154.1
	700	0.622	208.7	0.533	179.4
	800	—	—	0.610	204.5
34"	125	0.118	42.8	—	—
	150	0.142	51.3	0.121	44.0
	200	0.189	68.3	0.162	58.6
	250	0.236	85.2	0.202	73.1
	300	0.283	102.1	0.243	87.6
	400	0.378	135.8	0.324	116.6
	500	0.472	169.3	0.405	145.4
	600	0.567	202.5	0.486	174.0
	650	0.614	219.1	0.526	188.3
	700	—	—	0.567	202.5
36"	125	0.125	47.9	—	—
	150	0.150	57.5	0.129	49.3
	200	0.200	76.5	0.171	65.7
	250	0.250	95.5	0.214	82.0
	300	0.300	114.5	0.257	98.3
	400	0.400	152.2	0.343	130.7
	500	0.500	189.7	0.429	163.0
	600	0.600	227.1	0.514	195.1
	625	0.625	236.3	0.536	203.1
	700	—	—	0.600	227.1
38"	125	0.132	53.4	—	—
	150	0.158	64.1	0.136	54.9
	200	0.211	85.3	0.181	73.2
	250	0.264	106.5	0.226	91.3
	300	0.317	127.6	0.271	109.5
	400	0.422	169.6	0.362	145.6
	500	0.528	211.4	0.452	181.6
	600	0.633	253.0	0.543	217.4
	700	—	—	0.633	253.0
42"	125	0.146	65.2	—	—
	150	0.175	78.2	0.150	67.1
	200	0.233	104.2	0.200	89.4
	250	0.292	130.0	0.250	111.6
	300	0.350	155.8	0.300	133.7
	400	0.467	207.2	0.400	177.9
	500	0.583	258.3	0.500	221.8
	600	—	—	0.600	265.5

NWP0033058

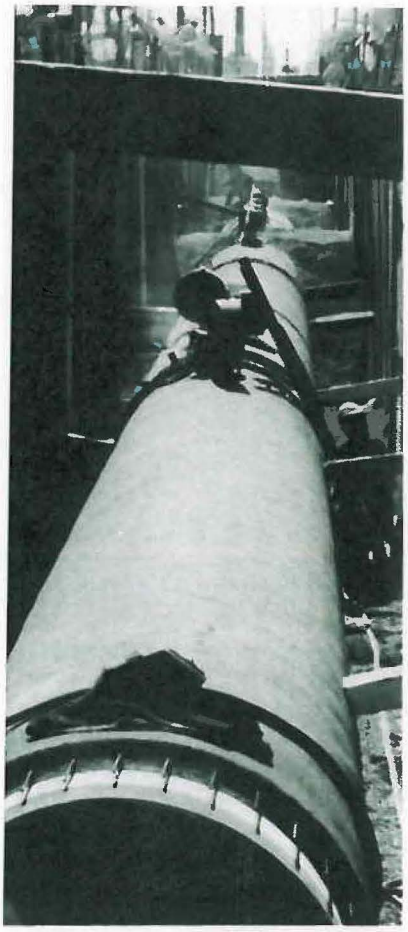
Northwest Pipe Company

WALL THICKNESS

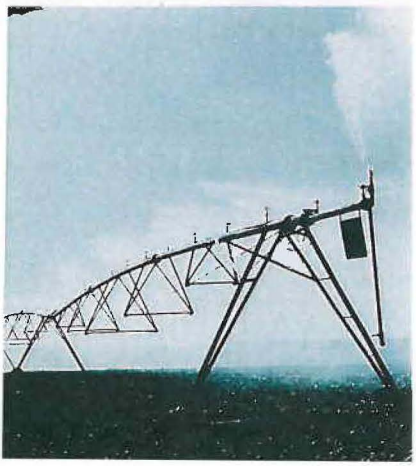
CALCULATED BY PRESSURE CLASS

PIPE O.D. INCHES	PRESSURE CLASS PSI	36 KSI YIELD STEEL	PIPE WEIGHT LBS./L.F.	42 KSI YIELD STEEL	PIPE WEIGHT LBS./L.F.
48"	125	0.167	85.2	—	—
	150	0.200	102.2	0.171	87.6
	175	0.233	119.1	0.200	102.2
	200	0.267	136.1	0.229	116.7
	250	0.333	169.9	0.286	145.7
	300	0.400	203.5	0.343	174.7
	400	0.533	270.6	0.457	232.3
	500	0.667	337.3	0.571	289.7
	550	—	—	0.629	318.3
54"	125	0.188	107.9	—	—
	150	0.225	129.3	0.193	110.9
	175	0.263	150.8	0.225	129.3
	200	0.300	172.2	0.257	147.7
	250	0.375	215.0	0.321	184.4
	300	0.450	257.6	0.386	221.1
	400	0.600	342.5	0.514	294.0
	450	0.675	384.8	0.579	330.4
	500	—	—	0.643	366.7
60"	125	0.208	133.2	0.179	114.2
	150	0.250	159.7	0.214	137.0
	175	0.292	186.2	0.250	159.7
	200	0.333	212.6	0.286	182.4
	250	0.417	265.4	0.357	227.7
	300	0.500	318.0	0.429	272.9
	400	0.667	422.8	0.571	363.0
	450	0.750	475.0	0.643	407.9
	500	—	—	0.714	452.7
66"	125	0.229	161.1	0.196	138.2
	150	0.275	193.2	0.236	165.7
	175	0.321	225.3	0.275	193.2
	200	0.367	257.3	0.314	220.7
	250	0.458	321.1	0.393	275.5
	300	0.550	384.8	0.471	330.2
	400	0.733	511.6	0.629	439.3
	450	—	—	0.707	493.6
72"	125	0.250	191.8	0.214	164.4
	150	0.300	229.9	0.257	197.2
	175	0.350	268.1	0.300	229.9
	200	0.400	306.2	0.343	262.6
	250	0.500	382.2	0.429	327.9
	300	0.600	458.0	0.514	393.0
	375	0.750	571.2	0.643	490.4
	400	—	—	0.686	522.8

NWP0033039



A 56" diameter outfall line in Tacoma, Washington.



Selection of Wall Thickness

WALL THICKNESS
CALCULATED BY PRESSURE CLASS

PIPE O.D. INCHES	PRESSURE CLASS PSI	36 KSI YIELD STEEL	PIPE WEIGHT LBS./L.F.	42 KSI YIELD STEEL	PIPE WEIGHT LBS./L.F.
78"	125	0.271	225.0	0.232	193.0
	150	0.325	269.9	0.279	231.4
	175	0.379	314.6	0.325	269.9
	200	0.433	359.3	0.371	308.2
	250	0.542	448.5	0.464	384.8
	300	0.650	537.5	0.557	461.2
	350	0.758	626.2	0.650	537.5
	375	——	——	0.696	575.5
84"	125	0.292	261.0	0.250	223.8
	150	0.350	313.0	0.300	268.4
	175	0.408	364.9	0.350	313.0
	200	0.467	416.7	0.400	357.5
	225	0.525	468.5	0.450	401.9
	250	0.583	520.2	0.500	446.3
	300	0.700	623.3	0.600	534.9
	325	0.758	674.8	0.650	579.2
	350	——	——	0.700	623.3
90"	125	0.313	299.6	0.268	256.9
	150	0.375	359.3	0.321	308.1
	175	0.438	418.9	0.375	359.3
	200	0.500	478.4	0.429	410.4
	225	0.563	537.8	0.482	461.4
	250	0.625	597.1	0.536	512.3
	275	0.688	656.4	0.589	563.2
	300	0.750	715.6	0.643	614.1
	325	——	——	0.696	664.8
96"	125	0.333	340.9	0.286	292.3
	150	0.400	408.8	0.343	350.6
	175	0.467	476.6	0.400	408.8
	200	0.533	544.3	0.457	466.9
	225	0.600	611.9	0.514	525.0
	250	0.667	679.4	0.571	582.9
	275	0.733	746.8	0.629	640.8
	300	——	——	0.686	698.7
102"	125	0.354	384.8	0.304	330.0
	150	0.425	461.5	0.364	395.8
	175	0.496	538.0	0.425	461.5
	200	0.567	614.4	0.486	527.1
	225	0.638	690.8	0.546	592.6
	250	0.708	767.0	0.607	658.1
	275	0.779	843.1	0.668	723.4
	300	——	——	0.729	788.7

Northwest Pipe Company

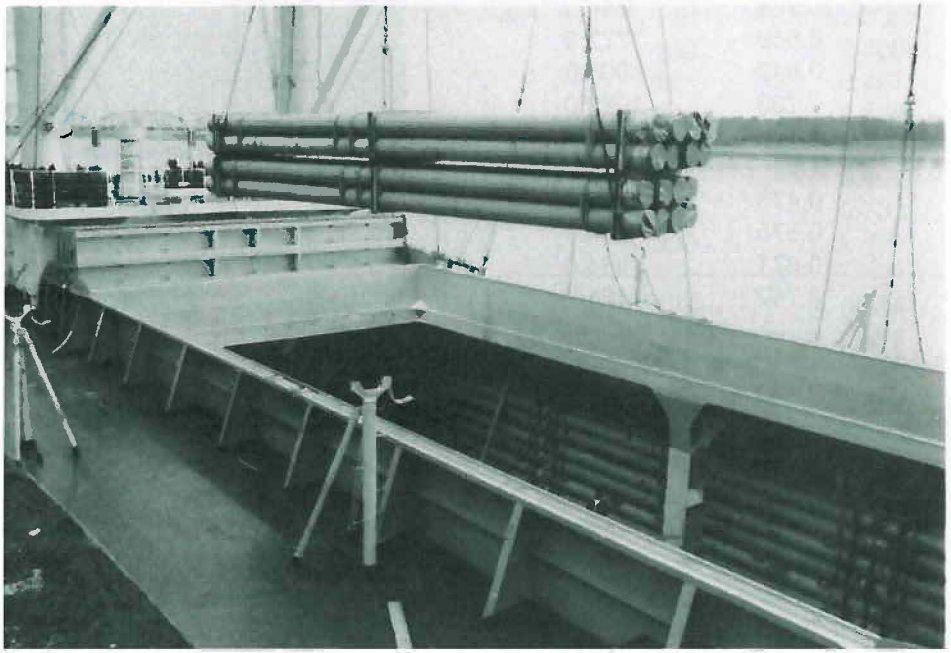
WALL THICKNESS

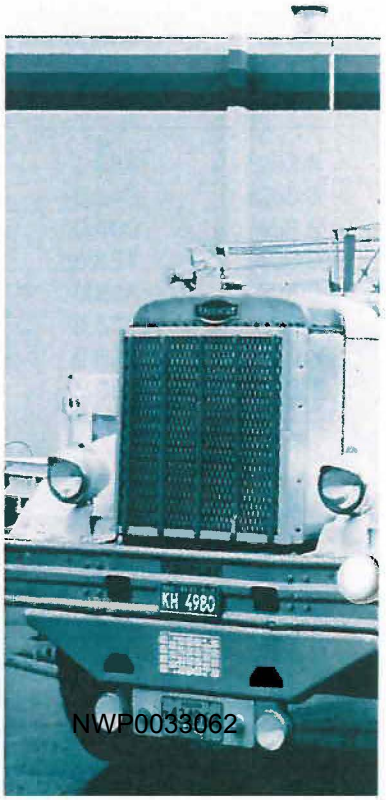
CALCULATED BY PRESSURE CLASS

PIPE O.D. INCHES	PRESSURE CLASS PSI	36 KSI YIELD STEEL	PIPE WEIGHT LBS./L.F.	42 KSI YIELD STEEL	PIPE WEIGHT LBS./L.F.
108"	125	0.375	431.4	0.321	370.0
	150	0.450	517.4	0.386	443.7
	175	0.525	603.2	0.450	517.4
	200	0.600	688.9	0.514	590.9
	225	0.675	774.4	0.579	664.4
	250	0.750	859.9	0.643	737.8
	275	—	—	0.707	811.1
114"	125	0.396	480.7	0.339	412.2
	150	0.475	576.5	0.407	494.4
	175	0.554	672.1	0.475	576.5
	200	0.633	767.5	0.543	658.4
	225	0.713	862.9	0.611	740.3
	250	—	—	0.679	822.0
120"	125	0.417	532.6	0.357	456.8
	150	0.500	638.7	0.429	547.8
	175	0.583	744.7	0.500	638.7
	200	0.667	850.4	0.571	729.5
	125	0.417	532.6	0.357	456.8
	150	0.500	638.7	0.429	547.8
126"	125	0.438	587.2	0.375	503.6
	150	0.525	704.2	0.450	604.0
	175	0.613	821.0	0.525	704.2
	200	0.700	937.6	0.600	804.3
	225	0.788	1054.1	0.675	904.3
	250	—	—	0.750	1004.2
132"	125	0.458	644.5	0.393	552.7
	150	0.550	772.9	0.471	662.8
	175	0.642	901.0	0.550	772.9
	200	0.733	1029.0	0.629	882.7
	225	—	—	0.707	992.5
138"	125	0.479	704.4	0.411	604.1
	150	0.575	844.7	0.493	724.5
	175	0.671	984.8	0.575	844.7
	200	0.767	1124.7	0.657	964.8
	225	—	—	0.739	1084.8
144"	125	0.500	767.0	0.429	657.8
	150	0.600	919.8	0.514	788.8
	175	0.700	1072.3	0.600	919.8
	200	0.800	1224.6	0.686	1050.5
	225	—	—	0.771	1181.1

Shipping and Handling

Northwest Pipe Company is a service-minded company that prides itself in fast, "on-time" delivery. Engineering and manufacturing, as well as shipping and handling, work together to assure prompt delivery. Each load is pre-built so that in most cases, pipe can be loaded in one lift and be on the road to the job site without delay.





NWP0033062

Northwest Pipe Company

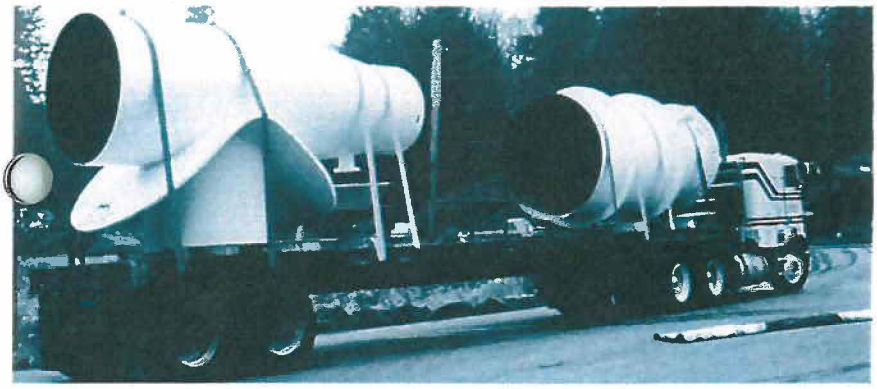
TRUCK LOADING SCHEDULE FOR BARE STEEL PIPE

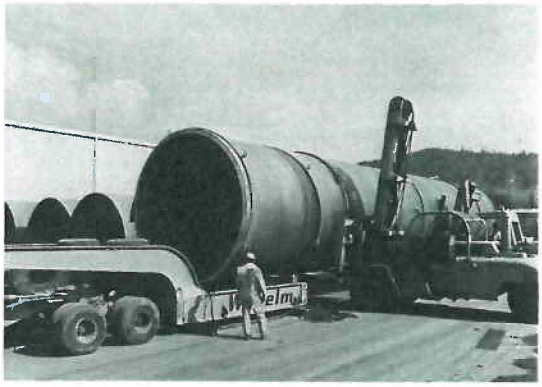
PIPE SIZE O.D.	NUMBER OF PIECES PER LAYER PLAIN ENDS	WELD BELL ENDS	O-RING ENDS	MAX LAYERS (102")
4-5"	22	20	18	18
5"	20	19	17	17
6"	16	15	13	14
6.625"	15	14	13	13
7"	14	13	12	12
8"	12	11	10	11
8.625"	11	10	10	10
10"	10	9	9	9
10.75"	9	8	8	8
12"	8	8	7	8
12.75"	8	8	7	7
14"	7	7	7	7
16"	6	6	6	6

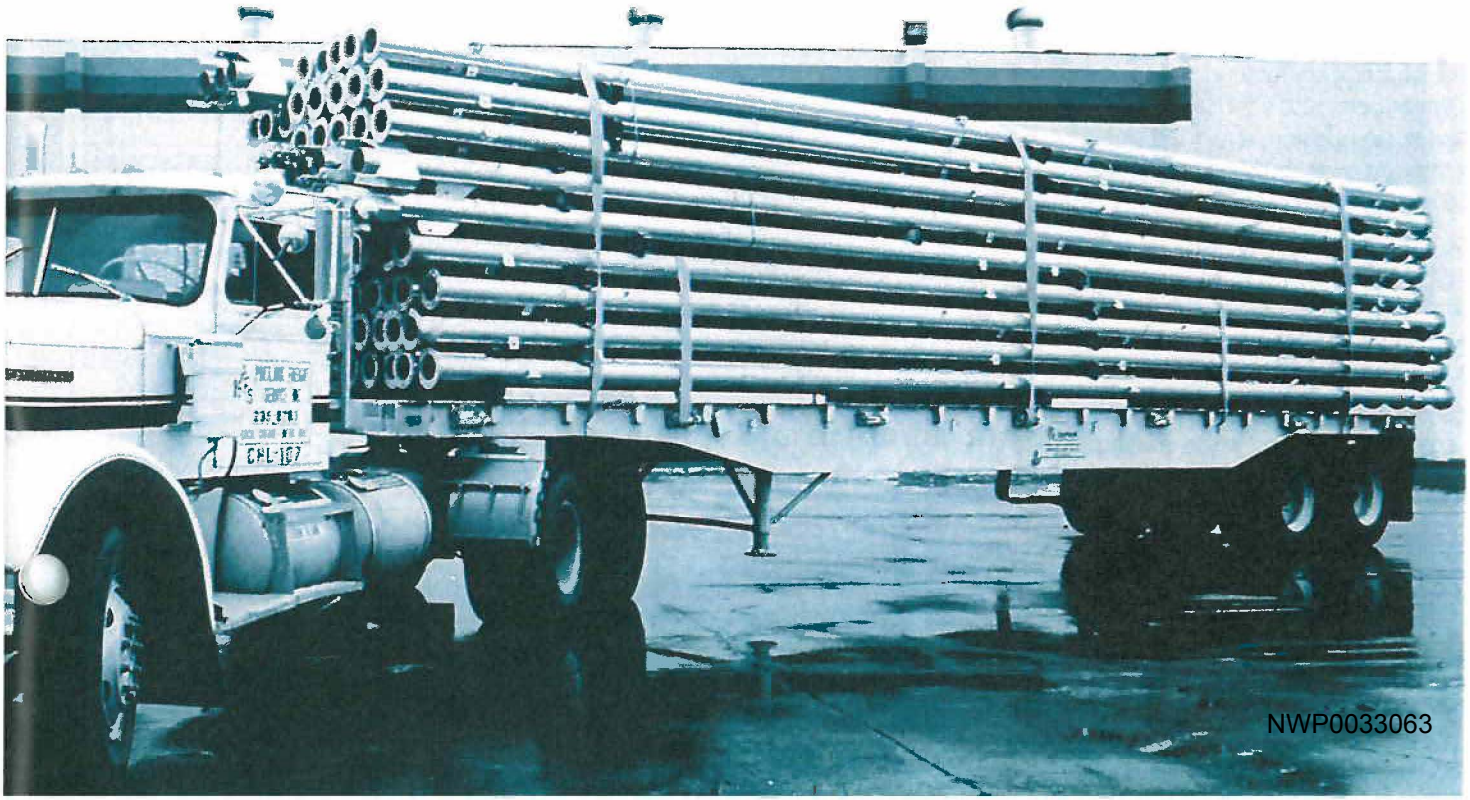
PIPE SIZE O.D.	NUMBER OF PIECES PER LAYER PLAIN ENDS	WELD BELL ENDS	O-RING ENDS	MAX LAYERS (102")
18"	5	5	5	5
20"	5	5	5	4/4**
24"	4	4	4	4
26"	3	3	3	3/2**
28"	3	3	3	3/2**
30"	3	3	3	3
32"	3	3	3	3
34"	2	2	2	2/1**
36"	2	2	2	2/1**
42"	2	2	2	2
48"	2	2	2	2
54"	1	1	1	2 pcs
60"	1	1	0	2 pcs w/ offset supports

*NOTE: 1" Dunnage Used between Layers of Pipe

** Cradled at Top







NWP0033063

Portland, Oregon Plant

Northwest Pipe Company's Portland facility offers 300,000 square feet of covered space on 20 acres of land. The plant is strategically located near two deepwater ports and interstate highways. In addition, a railroad siding runs through every building for loading.

The Portland facility manufactures welded steel pipe in sizes 3" OD through 144" OD with material thickness ranging from 14 gauge through 0.625" inch. This facility operates three spiral mills and two straight seam mills.

Portland's facility offers all of the linings and coatings described in the coating section of this publication.

A full-service operation offering complete fabrication and project engineering, Northwest Pipe Company's Portland plant offers the following capabilities.

SPIRAL WELD STEEL PIPE (Submerged arc welded)

- Sizes: 17" OD through 144" OD
- Wall thickness: 0.105" through 0.625"
- Hydro-tested lengths: 20' through 60'
- Non-hydrostatically tested lengths: up to maximum shipping ability

STRAIGHT SEAM ERW STEEL PIPE

- Sizes: 3" through 16" OD
- Wall thickness: 0.0625" through 0.250"
- Coupler: 4" OD through 12" OD

TYPICAL MANUFACTURING SPECIFICATIONS
AWWA
C200
ASTM
A-53 Grade A, A-134, A-135 Grade A,
A-139 All Grades, A-252, A-795 Grade A
SPRINKLER PIPE
• ASTM A-135 Grade A
• ASTM A-795 Grade A
• Meets NFPA No. 13
• UL Listed, FM Approved
STAINLESS STEEL PIPE
• ASTM A-409 HT-0
• ASTM A-778 HT-0

NWP0033064

END TREATMENTS

Rolled groove O-rings, well bell, victaulic weld-on and roll groove, flanged, flexible coupling, beveled, Carnegie bell and spigot, square cut, plain end

LININGS AND COATINGS

Linings

- Coal tar enamel AWWA C-203
  Sizes 4" through 108"
- Cement mortar AWWA C-205
  Sizes 12" through 84", NSF Certified
- Coal tar epoxy and all specialty paint
  Sizes 4" through 108"
- T&O solution
  Sizes 4" through 108"

Coatings

- Coal tar enamel AWWA C-203
  Sizes 4" through 108"
- Polyethylene tape AWWA C-214
  Sizes 6" through 108"
- Cement mortar AWWA C-205
  Sizes 12" through 84"
- Zinc primers and specialty paints
  Sizes 4" through 108"

AVAILABLE SHIPPING

Rail, barge/ship, truck, piggyback

Northwest Pipe Company
12005 N. Burgard
P.O. Box 83149
Portland, Oregon 97283-0149

Outside Oregon: 800-824-9824 (toll-free)
Oregon number: 503-285-1400
FAX: 503-285-2913

Atchison, Kansas Plant

The Kansas Division serves the agricultural, manufacturing, and fire protection pipe needs of the Midwest.

Strategically located just one hour from Kansas City, this modern 40-acre facility offers 60,000 square feet of under-roof manufacturing space.

STEEL PIPE AND TUBING AVAILABLE AT KANSAS

Size Range

4" OD	8-5/8" OD
4-1/2" OD	10" OD
5" OD	10-3/4" OD
6" OD	12" OD
6-5/8" OD	12-3/4" OD
7" OD	14" OD
8" OD	16" OD

Wall Thickness

4" - 7"	0.083" - 0.188"
8"	0.083" - 0.250"
8-5/8" - 16"	0.105" - 0.250"

TYPICAL MANUFACTURING SPECIFICATIONS
ASTM
A-53, A-135, A-252, A-500, A-795
API
5LX-42, 5L GRADE B
SPRINKLER PIPE
• ASTM A-795 GRADE A
• Meets NFPA No. 13
• UL Listed
• FM Approved

LIGHTWALL STEEL PIPE AND TUBE

- Custom lengths
- Centrally located
- Prompt, courteous service
- Reliable high quality
- FLAME-OUT® Sprinkler Pipe
- EZ-FLOW Sprinkler Pipe

STEEL CAPABILITIES

- Hot Rolled: C1010-C1020/AKDQ
- Galvanized

END TREATMENTS

Victaulic weld on and roll groove, beveled, square cut, plain end

COATINGS

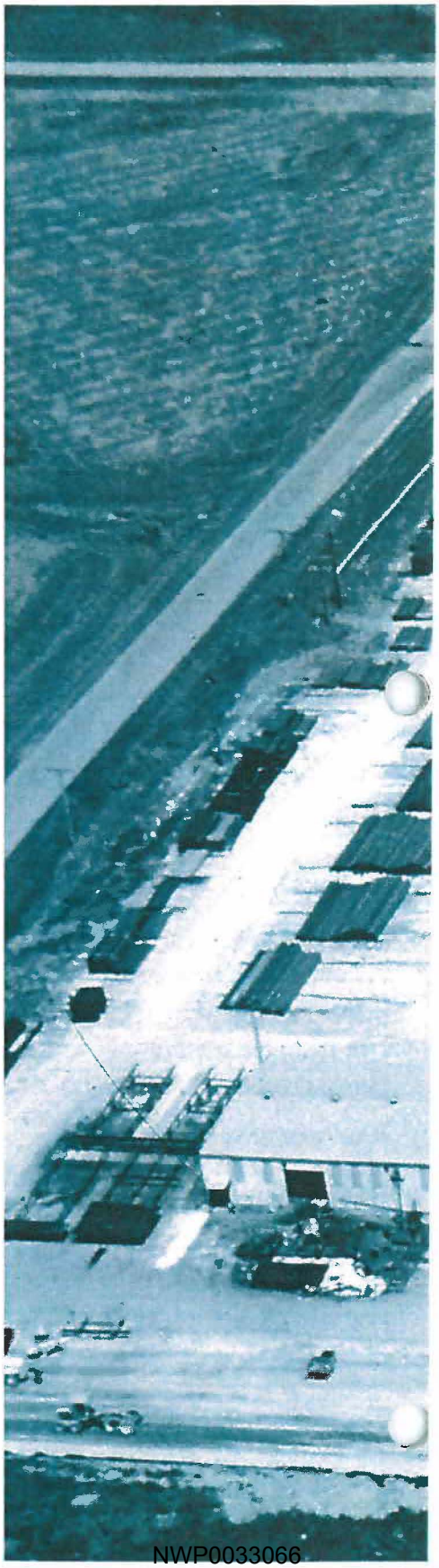
Various coatings are available on request.

AVAILABLE SHIPPING

Rail, barge/ship, truck, piggyback

Northwest Pipe Company
8154 Industrial Park Lane
P.O. Box 610
Atchison, Kansas 66002-0610

800-423-0677 (toll-free)
Kansas number: 913-874-4011
FAX: 913-874-2801



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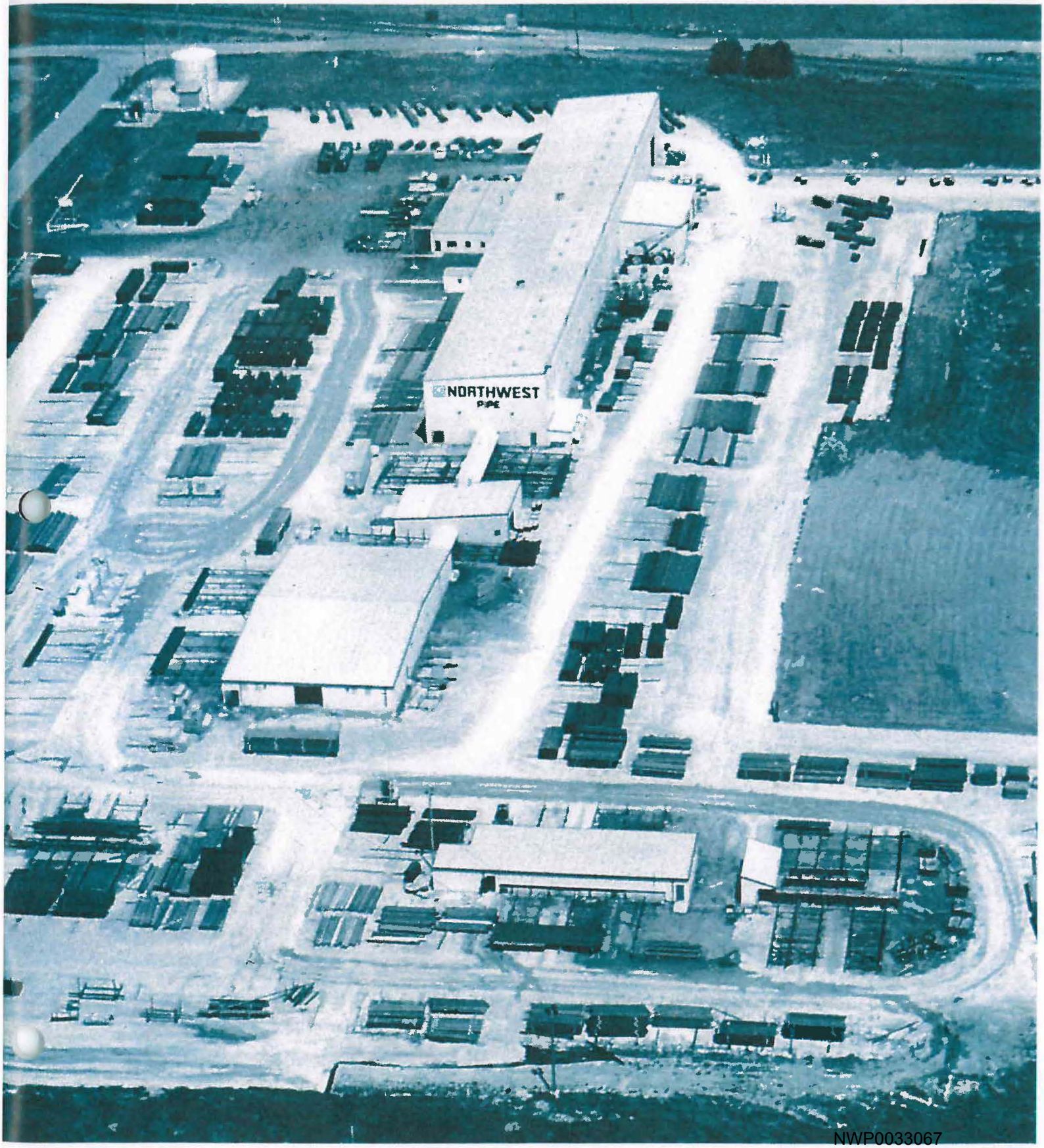
Northwest Pipe Company



NWP0033067

Strategically located just 90 minutes northeast of Los Angeles in Adelanto, California, the California Division produces a wide range of large-diameter spiral weld steel pipe products and complete engineered water transmission systems within convenient and economical shipping distances to customers in Southern California, New Mexico, Arizona, Nevada, and Utah.

The state-of-the-art plant offers 70,000 square feet of covered manufacturing space on 60 acres of prime industrial land.

This full-service operation offers comprehensive engineering and estimating services. Production capabilities include two spiral weld mills, complete fabrication as well as coating and lining.

The California Division manufactures spiral welded steel pipe in sizes 24" OD to 156" OD with material thickness up to 0.750" and has complete engineering and estimating capabilities.

The following outlines the capabilities of the Adelanto, California plant.

SPIRAL WELD STEEL PIPE (Submerged arc welded)

- Sizes: 24" OD through 156" OD
- Wall thickness: 0.1245" through 0.750"
- Hydro-tested lengths: 20' through 60'
- Non-hydrostatically tested lengths: up to maximum shipping ability

NWP0033068

TYPICAL MANUFACTURING SPECIFICATIONS
AWWA
C-200
ASTM
A-134, A-139, A-252, A-500

END TREATMENTS

Rolled groove O-rings, weld bell, victaulic weld-on and roll grove, flanged, flexible coupling, beveled, Carnegie bell & spigot, square cut, plain end

LININGS AND COATINGS

Linings

- Cement mortar AWWA C-205
  Sizes 24" through 96"
- Coal tar epoxy and all specialty paint
  Sizes 24" through 144"

Coatings

- Polyethylene tape AWWA C-214
  Sizes through 144"
- Cement mortar AWWA C-205
  Sizes 24" through 144"
- Zinc primers and specialty paints
  Sizes through 156"

AVAILABLE SHIPPING

Rail, truck, piggyback

Northwest Pipe Company
12351 Rancho Road
Adelanto, California 92301

Telephone: 619-246-3191
FAX: 619-246-2292

Products/Applications

Agriculture
Surface and underground irrigation mains
Submains
Water supply and dewatering
Gravity spouts for grain handling
Blowpipe for grain
Enclosure for screw conveyors
Water well casing
Perforated pipe for well screens

Construction
Foundation pipe
Caisson pipe
Railroad and road casing pipe
Air lines
Water lines
Hydraulic sluicing pipe
Exhaust and intake lines
Force mains
Raw water lines
Transmission and distribution lines
Aerial crossings
Tunnel liners
Siphons
Penstocks
Underwater crossings
Well point headers
Ventilating lines
Drainage
Dewatering
Bridge crossings
Ocean sewer outfalls
Struts
Sheet piling bracing

Dredging
Pontoon pipe
Shore pipe
Sand and gravel conveying, abrasive resistant
All types of dredging connections

Manufacturing Plants
Waste lines
Drainage lines
Water piping and manifolds
High- and low-pressure air lines
Ventilating lines
Filtration pipe
Exhaust and intake lines
Cooling tower pipe
Water supply
Low-pressure steam exhaust lines
Spray pond pipe
Bridge crossings

Materials Handling
Pneumatic conveyors
Conveying lines
Slurry pipe
Clay slip pipe
Coat slurrying
Conveyor tube galleries

Mining and Quarrying
Sand, gravel and other material
Wash water lines
Slurry pipe
Rubber-lined pipe
Sludge and trailing lines
Hydraulic lines
Ventilating lines
Coal Gilsonite
Process plant piping—feed lines, wash lines, refuse lines
Tailings lines
Dewatering lines
Water supply lines
High- and low-pressure air lines

Paper and Wood Mills
Wood chip lines
Bark lines
Sawdust blowpipe
Pulp lines
Compressed air lines
Condensate lines
Stock lines
Ventilating lines
White water lines
Pneumatic conveying lines
Hot- and cold-water lines
Steam exhaust

Petroleum and Gas
Sludge lines
Salt water disposal
Tank gauge and swing lines
Vapor recovery piping
Dewatering lines
Syphon pipe
Offshore drilling platforms

Phosphate Slurry Lines

Piling

Power Plants
Coal
Feed lines
Fly ash refuse
Circulating water

Structural Applications
Tank legs
Highway and railroad casing
Columns
Portable grain conveyors
Containers
Offshore drilling rigs
Sign posts

Water and Waste Treatment
Aeration lines
Filtration plant pipe
High- and low-pressure water lines
Outfall lines
Sludge lines
High- and low-pressure air lines
Force mains

NASPD

AMERICAN FIRE SPRINKLER ASSOCIATION, INC.

Factory Mutual System
Approved

Associate Member Steel Service Center Institute

UL
Listed

c UL
Listed

Northwest Pipe Company

NWP0033070

EXHIBIT S-24-1.11

NORTHWEST PIPE

QUALITY PRODUCTS FROM A SERVICE-MINDED MANUFACTURER

NWP0033072

Quality Products from a Service-Minded Manufacturer

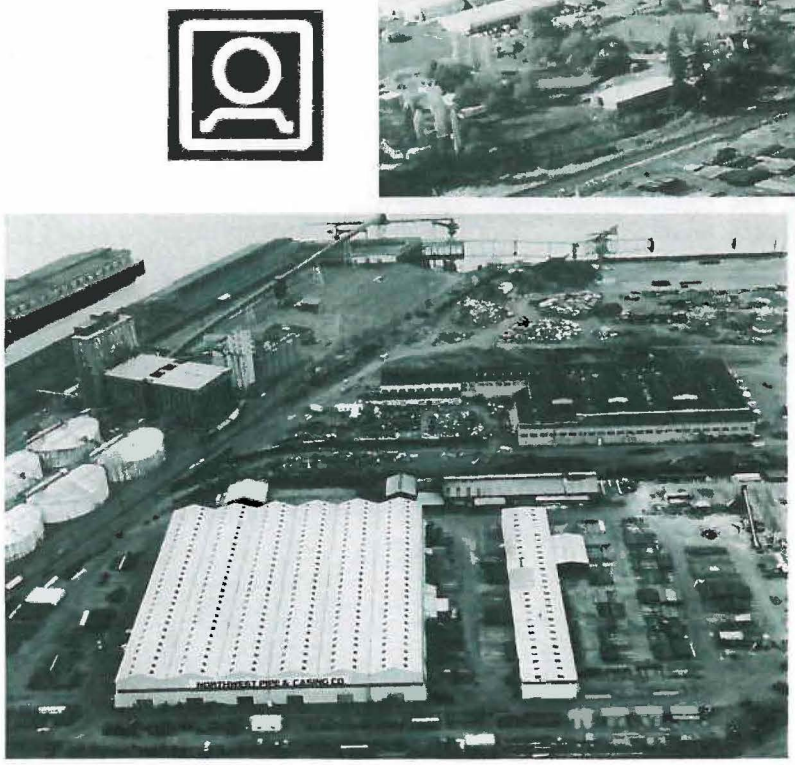
BRIEF HISTORY

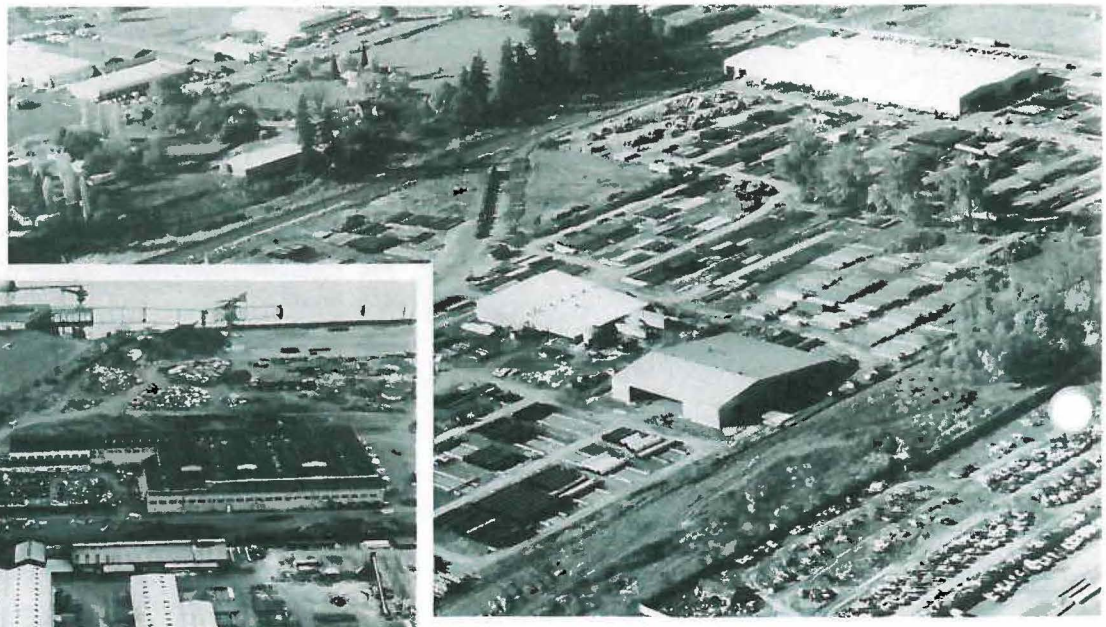
The purpose of this brochure is to introduce you to Northwest Pipe and to expose you to our products and services.

Northwest Pipe began manufacturing steel pipe in 1967 in Clackamas, Oregon, and continued to grow by acquisitions, adding pipe mills and expanding product lines. Acquisitions include the manufacturing facilities of Hall Process and Beall Pipe & Tank. We have just recently opened two new steel pipe manufacturing facilities, one in Kansas (for 3" through 16" tubing), the other in California (where spiral pipe will be made through 154" diameter). All sizes are made in Oregon.

Northwest Pipe manufactures steel pipe and fittings and applies protective linings and coatings. You will also find in this brochure the sizes of steel pipe available.

This brochure is not meant to be all-inclusive. If you have special needs, please give us a call at (503) 659-5650, or outside Oregon 1-800-824-9824.





ABOVE: Clackamas Plant

LEFT: North Portland Plant

LININGS & COATINGS

Northwest Pipe offers a number of quality linings for the interior of steel pipe, some of which are approved for potable water by the American Water Works Association (AWWA).

Linings that have been applied at the Oregon plants include:

- **Coal Tar Enamel (AWWA C-203)**
- **Cement Mortar (AWWA C-205)**
- **Bitumastic Tank Solution**
- **Two Component Epoxies**

Exterior Coatings include:

- **Coal Tar Enamel (AWWA C-203)**
- **Two Component Epoxies**
- **Polyethylene Tape**
- **Fused Epoxy Powder**
- **Extruded Polyethylene**

SPECIFICATIONS

Some of the specifications that Northwest Pipe uses:

ASTM: A-53, A-120, A-134, A-135, A-139, A-211, A-252, A-500, A-513
AWWA: C-200
API: 5L and 5LX

Industries using Northwest's steel pipe include:

agriculture	manufacturing	paper & wood products
construction	materials handling	petroleum and gas
energy	mining	water & waste water
dredging		

MATERIAL

At Northwest Pipe, we utilize steel sheet in coil form normally having yield strengths in the 36,000 to 44,000 psi range. However, if design conditions require other yields, then steels with the physicals shown below are available on an individual order basis.

ASTM Sheet Steels for Steel Pipe & Tubing

Specification	A-36	A-570						A-572 (Modified)			
Grade		30	33	36	40	45	50	42	50	60	65
Yield Point, Minimum psi	36,000	30,000	33,000	36,000	40,000	45,000	50,000	42,000	50,000	60,000	65,000
Usual Design Stress, 50% Yield, psi	18,000	15,000	16,500	18,000	20,000	22,500	25,000	21,000	25,000	30,000	32,500
Tensile Strength, Minimum psi	58,000	49,000	52,000	53,000	55,000	60,000	65,000	60,000	65,000	75,000	80,000

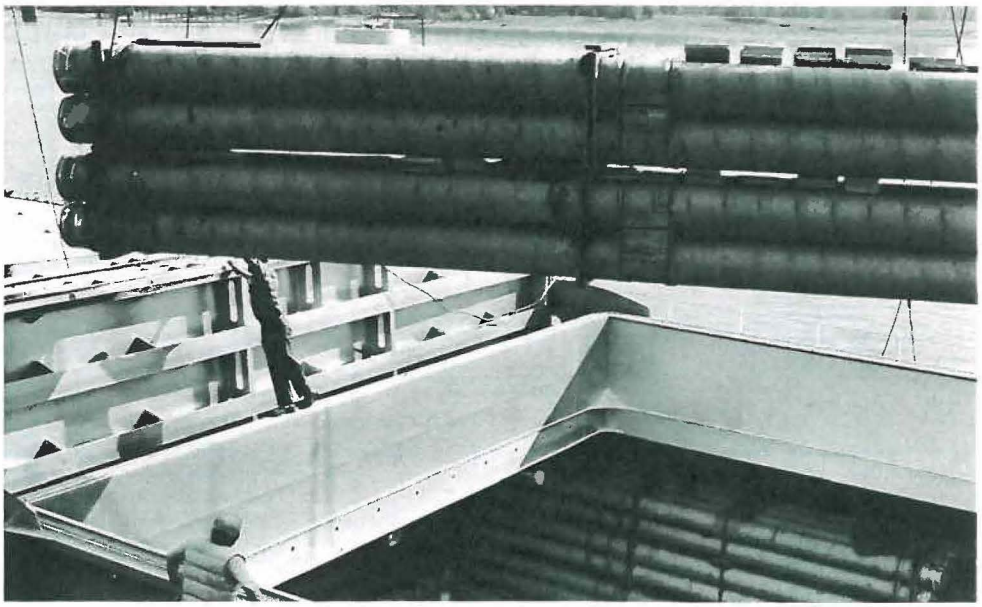
*Other alloy and fine-grain steels, and steels meeting the requirements of **AISI-C1010 through C1020,** are available upon request.*

WALL THICKNESS SELECTION

Pricing is enormously affected by the thickness of steel required in the pipe. One method for determining thickness is by use of the Barlow Hoop tension formula:

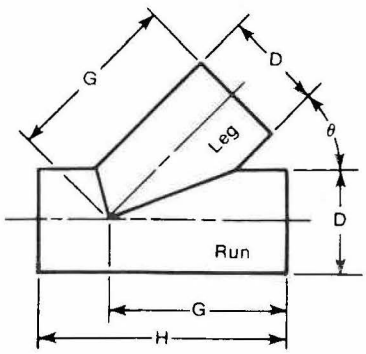
$$t = \frac{PD}{2S}$$

where t = wall thickness in inches
P = internal design in psi
D = outside diameter in inches
S = allowable stress (normally 50% of specified yield, psi)

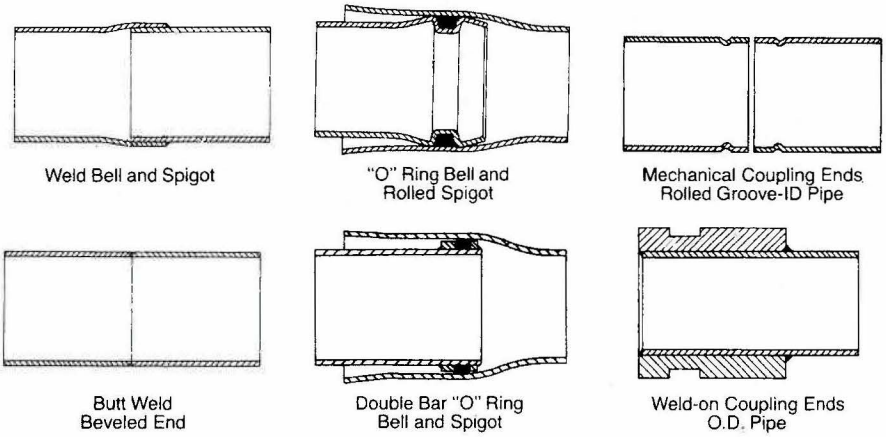


NORTHWEST PIPE FITTINGS

Steel fittings can be fabricated to fit practically any configuration including elbows, tees, laterals, and reducers.



END PREPARATIONS



STEEL PIPE SIZES

Northwest Pipe manufactures pipe in two separate processes.
Electric Resistance Welded Tubing is made from steel coil in the following diameters and wall thicknesses:

O.D. SIZE	WALL THICKNESS
3″	min. .0747 (14 GA)
3½″	through
4″	through
4½″	through
5″	through
6″	through
6⅝″	through
7″	max. .1875 (3/16″)

O.D. SIZE	WALL THICKNESS
8″	min. .0747 (14 GA)
8⅝″	through
10″	max. .250 (¼″)
10¾″	min. .1045 (12GA)
12″	through
12¾″	through
14″	through
16″	max. .250 (¼″)

Spiral Seam Sub-Arc Welded Pipe *is made in any size between* ***18″ OD through 154″ OD.*** *Steel thickness can range from 12 gauge (****.1045****) through ¾″ (****.750****). Custom lengths off spiral mills have been furnished up to* ***130′*** *long.*

NORTHWEST PIPE & CASING CO.
9200 S.E. LAWNFIELD RD., P.O. BOX 38
CLACKAMAS, OREGON 97015